Instruments

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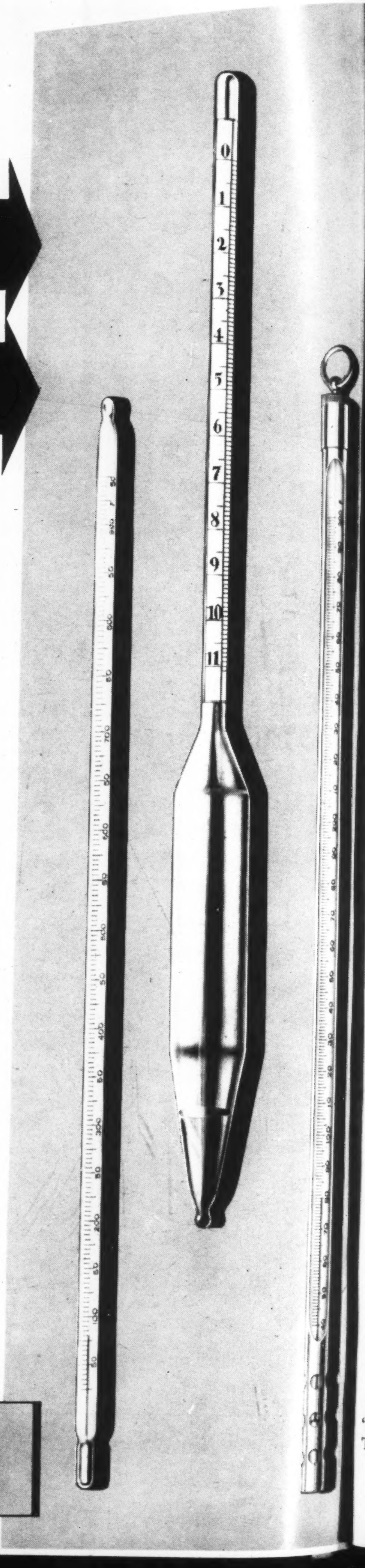
INCLUDING Aviation Instruments



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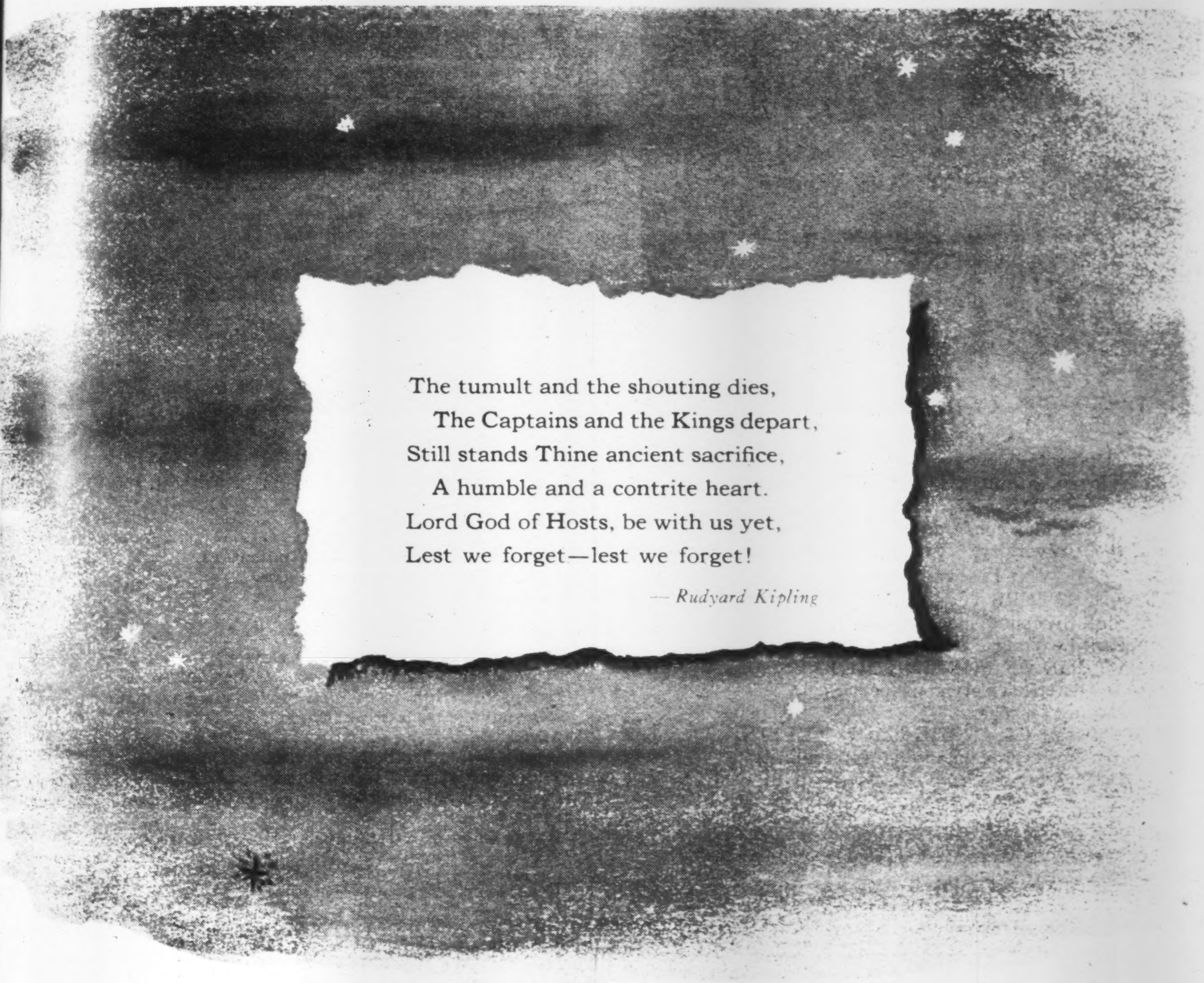

The tumult and the shouting dies,
The Captains and the Kings depart,
Still stands Thine ancient sacrifice,
A humble and a contrite heart.
Lord God of Hosts, be with us yet,
Lest we forget—lest we forget!

— *Rudyard Kipling*

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Instruments THE MAGAZINE OF *Measurement and Control*

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RICHARD RIMBACH, *MANAGING EDITOR*
M. F. Béhar, *Editor*
Paul Conrad, *Associate Editor*
Malcolm Lovejoy, *Assistant Editor*

DISTRICT OFFICES AND MANAGERS

Boston 14: James Condon, 36 Myrtle St., Telephone Lafayette 0829
Cleveland 14: C. Goldcamp, 859 Leader Bldg., Cherry 2261
New York 17: R. K. Farnham, Room 617, 17 East 42nd St., Telephone Murray Hill 2-0821.
Chicago 1: Harold W. Haskett, Room 615, 360 N. Michigan Ave., Telephone Andover 4299
Cincinnati 2: Harold W. Haskett, Keith Bldg., Telephone Main 4260
St. Louis 1: James R. Wright, 915 Olive St., Telephone Chestnut 1965
Pasadena 1: M. D. Pugh, 35 S. Raymond Ave., Telephone Madison 6272
Pittsburgh 12: C. Goldcamp, 1117 Wolfendale St., Telephone Fairfax 0161
Philadelphia: Stuart Rogers, contact at New York office

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EDITORIAL By M. F. BEHAR

The Conference on Instrumentation and the University

IN direct and indirect ways, the future careers of most *Instruments* subscribers will be affected by the AIS-CIT Conference to be held October 16-18. Next month's issue of *Instruments* will report the proceedings in stenographic completeness. Most regular features will be crowded out; even this editorial page will be used for a speech to be selected by the committee in charge; therefore your editor has been asked to "open" the Conference on this page this month with remarks on EDUCATION in INSTRUMENTATION, as distinguished from training in the use of instruments.

Instead of re-hashing extracts from what we have written on this subject since 1924 and presenting it as "new," we prefer the straightforward way of direct quotations from some of our old editorials—editorials written for all subscribers in general rather than for university professors:

[Oct. 1935. Title: "Advancement"]

One good thing about the science of Instrumentation is its universality. For example, the ideas given by R. C. Wenz in his traffic-counting article are applicable to factory production; and they WILL be applied in industrial plants where *Instruments* is read; and the production men who introduce them will, we hope, win promotions.

[Dec. 1936. Title: "Too Many Bolt-tighteners"]

Automaticity cuts down the sum total of repetitive drudgery and creates jobs for skilled workers: upstanding, law-abiding, satisfied workers. The age of Instrumentation is almost here. It will come when there are enough Instrumenticians.

[March 1940: "'Laboratory' and 'Plant' Instruments"]

There is a field of testing of finished products which has "gone scientific" at such a rapid rate that technicians cannot be trained fast enough to fill the vacancies. We refer to modernized performance testing of products from household appliances to turbogenerators, engines, aircraft, etc.

[June 1940: "Education and Training Urgently Needed"]

"Education is the defense of nations."—EDMUND BURKE

"Civilization is a race between education and catastrophe."
—H. G. WELLS

Every great emergency has caught our peace-loving American people unprepared . . . Today's technological difficulties differ greatly from those which American Industry surmounted in 1917-'18.

There is a dearth of skilled instrument makers, instrument maintenance men, etc. Most critical of all, however, is the shortage of Instrumenticians: of thoroughly educated engineers capable of solving fundamental problems and overcoming difficulties through the scientific application of measurement and control to munitions production.

. . . THE HIERARCHY FROM "CHART BOY" TO INSTRUMENT ENGINEER PARALLELS THAT FROM "GREASE MONKEY" TO AERONAUTICAL ENGINEER . . . The time has come to speak plainly: It is the duty of American engineering schools to inaugurate thorough courses in Instrumentation NOW.

[May 1941. Title: "Bandwagon?"]

Courses in measurements, metering, and even automatic control, are springing up throughout the country. In one sense, this is "only a by-product" of the Defense effort. This view is neither entirely false nor entirely true.

That it is not entirely false is evident from the fact that in 1915-17 there was a similar spurt in the training of testers and inspectors. Since it was not until 1924-29 that Instrumentation began to be formulated as a science, what is happening now might be "history repeating itself."

But it is not entirely true: Courses during the First World War were derived from Metrology. Today's courses are derived from Metrology *cum* Instrumentation.

Metrology might be called the science of measuring dead things like a thread angle, a grain size, a yield point, a scratch hardness, etc. Instrumentation begins with measurements but it goes on to deal with "living" things in industry—furnaces and stills and vulcanizers and all kinds of active equipment. Instrumentation deals with their behavior. One of its aims is to make them behave.

Instrumentation cuts across industry boundaries. Holding the assigned frequency of a broadcasting station "on the nose" and holding fractionating-tower temperatures and flows "on the nose" are two similar problems. Their solutions are based on the same Instrumentation fundamentals as are solutions of problems involving the automatic control of pressure and pH and plasticity and pickling and polymerization—and processing in general.

Engineering educators as a profession are at last "recognizing" Instrumentation. We never doubted that this recognition would come. We predicted it in 1924 (when the word "Instrumentation" offended most professorial ears) because of the inspiration we received from a high-minded and far-seeing pioneer in technical education: the late Nissim Béhar. But the sudden rise is like one of those chemical processes that smolder for hours then go blooey if you don't add the inhibitor at the right moment. Yes, it looks like they're jumping on the bandwagon.

Whose bandwagon? Perhaps that of any politician shrewd enough to produce a shiny vehicle and label it "Official Car." That's usually the way it goes.

But there are signs that the movement will not get out of hand; for the hands being stretched out to grasp the reins of its guidance are those of experienced professors.

In conversations with engineering professors we were asked to sum up the difference between Instrumentation and the use of instruments. The word "life" might do it as hinted a few paragraphs back. One criterion is that in an instrument laboratory (metrology sense) the students measure dimensions, properties of matter and even variables, but in an Instrumentation laboratory they would study Automatic Control by working with "living" apparatus like the one suggested by Fig. 1 on page 124.*

[Feb. 1942. Title: "But Instrumentation Is a Science"]

. . . This suddenly intensified interest in instrument education and training is all for the good of our nation and of our American way of life. It foreshadows a high American standard of living after the defeat of Hitler and Hirohito when American Industry will again face a big job . . .

Although the picture is good on the whole, it is far from being excellent when scrutinized. In the first place it is sporadic, spotty and jerky . . .

In the second place it is largely a rush to climb on the bandwagon. Some of those who sit smugly on top and smile into camera lenses are the very ones who yesterday were pelting with rotten eggs the handful of pioneer builders of the bandwagon. Well, that's the way it goes in a world of non-angelic human beings. I disagree with my fellow pioneers who explode with anger because, as they say, "ignoramuses are being put in charge of instrument courses and other ignoramuses are writing and publishing a lot of tripe." My viewpoint is that in this emergency *anything is better than nothing*. One of our missions as pioneers, however, is to hold fast to the custodianship of Instrumentation as a science, to HOLD UP THE TORCH OF SOUND SCHOLARSHIP AS AN IDEAL, to maintain and strengthen the foundation on which all newcomers may build, to continue sowing seeds unselfishly so that others may reap.

P. S.

And now, on behalf of you who will benefit from the Conference, your editor (who has only used WORDS) thanks the Committeemen who have done the WORK: the arrangements represent hundreds of man-hours of 'phoning, dictating letters, subcommittee meetings, even traveling. These WORKERS forbid me to name them. (But the COMPLETE proceedings *will* be printed in our next issue!) —MFB.

---

*This was a diagram of a closed-loop dynamical system—specifically a temperature controller and a continuous-process equipment.

Special Testers for High-precision Mechanisms

Extension Spring Tester, Torsion Spring Tester, Torque Meter, Strobotac Calibrator and Ball-bearing Tester.

By LAN J. WONG, Research Laboratories, Sperry Gyroscope Co., Garden City, N. Y.

INTRODUCTION

IN the course of development work on small accurate mechanisms, there are occasions when components such as springs, etc., need to be tested. Commercially-available equipment may be either not available or unsuitable for the situation at the moment. Consequently there are in various laboratories unique pieces of test equipment whose existence is known to only a few. This article will be concerned with some apparatus which may fall into that category.

EXTENSION SPRING TESTER

The extension spring tester is shown in Fig. 1. It consists mainly of a pivoted beam on which the spring force on one end is balanced by a weight on the other. The spring force is produced by using a rack-and-pinion arrangement to pull on the lower end of the spring and stretch it. The beam support structure and rack support block are both mounted on a base plate which can be leveled by means of three screws. The dial indicator support and a small rack for storing the weights are also fastened to the base plate.

As shown, the springs are held by hooks at either end. However, various attachments may be substituted as desired for any type of fastening, since the hooks are merely screwed into place. A yoke-and-pan arrangement was made up for use with compression springs.

No great effort was expended to obtain extreme accuracy but the normal errors may be considered quite small for all practical purposes. The weights used, while somewhat crude in appearance, are each accurate to 0.0001 lb. with the plus and minus errors so distributed that they will tend to cancel out in a group. The beam magnification for the weights is 3 to 1. The spring deflection is read on a dial indicator with 0.001″ graduations and a total travel of one inch. The broad blade type beam pointer with the help of the 2½ power magnifying lens can be consistently zeroed to within 0.0025″. Since the beam magnification for the pointer is approximately 3½ to 1, the error in location of the upper end of the spring is then 0.0007″. Consequently, one may expect to determine the spring deflection within 0.0012″ and the spring force within 0.0009 lb. or better (weight magnification of 3), assuming the use of several weights.

Knife edges are used for the pivots on the beam and have a low enough fraction so that if the beam is balanced in a stable fashion at zero and then disturbed, it will keep on swinging for more than twenty minutes before stopping. To help stop this swinging in a short time, a paddle type viscous damper is used. The main knife-edge member has an arm extending downward which swings with the beam. The lower end of the arm terminates into a paddle submerged in the oil contained in a rectangular can. The drag of the oil on the paddle tends to slow and finally stop the swinging. The heavier the oil, the faster does the beam stop. To keep the body of oil from sloshing back and forth in time with the paddle, a perforated plate is placed immediately on the surface of the oil.

It can be noticed that there are two counter-weights on screw studs, one horizontal, the other vertical. Adjusting the vertical weight will tend to shift the center of gravity of the beam up and down to vary the type and degree of stability of the beam. That is, the beam can be made more or less stable and unstable. When the beam is stable, its center of gravity is below the pivot line of the knife edges. It will always oscillate back to its equilibrium position when pushed off the zero point. The unstable beam has its center of gravity above the knife edges and will flop over to one side or the other of the zero point and stay there. Varying the degree of stability will result in a change of the beam sensitivity. At present, this may be varied from 0.001 lb. to 0.00015 lb. per scale division. That is, at maximum sensitivity, a spring force of 0.00015 lb. can move the pointer a distance of one division (0.100″) on the scale.

The beam assembly with the scale may be moved up and down by means of coarse and fine adjustments. The assembly is fastened to the end of a tube which may be moved by rotating horizontal knob *F* to operate a screw stud for fine adjustment. The bottom of the tube is threaded to take the stud. The tube may be clamped in its guide by tightening knob *L*. The tube guide and screw stud support mount on a slider which is clamped to the back support by using knob *C* to tighten a gib on the way.

The weight of this sliding assembly is counter-balanced by a spring-and-pulley arrangement to allow a greater ease of adjustment.

The rack-and-pinion arrangement for stretching the springs may be operated either directly or through a worm-and-wheel reduction gear drive. The worm shaft is swiveled in the mounting block so that the worm may be swung into or out of mesh with the wheel.

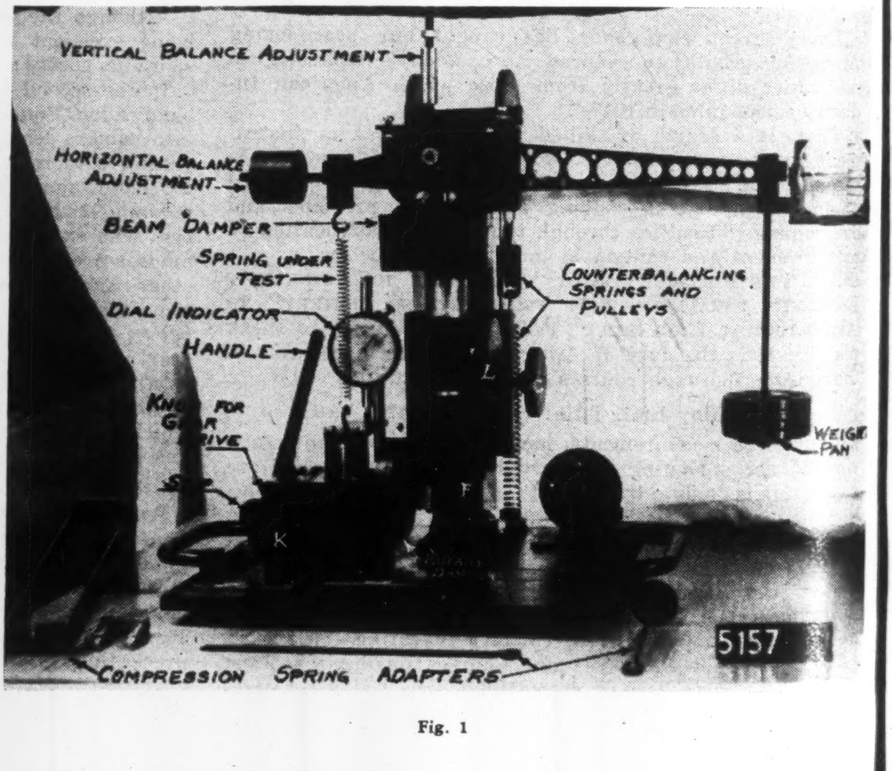
VERTICAL BALANCE ADJUSTMENT
HORIZONTAL BALANCE ADJUSTMENT
BEAM DAMPER
SPRING UNDER TEST
DIAL INDICATOR
HANDLE
KNOB FOR GEAR DRIVE
COUNTERBALANCING SPRINGS AND PULLEYS
L
F
K
WEIGH PAN
5157
COMPRESSION SPRING ADAPTERS

Fig. 1

A piece of spring wire acts as a detent to maintain the worm shaft in either position by acting on the shaft extension at the rear of the mounting block. Knob *K* rotates the worm.

For somewhat more rapid standardized checking, a handle is used to stretch the springs. It is provided with stops for either end of its travel so that any range of spring deflection may be set in and maintained. The front stop to limit the end of the travel uses a screw to provide a fine adjustment. The rear stop determines the highest position of the rack. It consists of a screw stud which can be inserted into any of sixteen threaded holes in the side of the mounting block to stop the handle. The housing for a rotary type viscous damper may be seen on the other side of mounting block. It is merely a flanged disk fastened to the pinion shaft and enclosed by a two-part fixed housing shaped on the inside so that the gap from the sides of the disk to the housing walls will be always 0.010″. The lower part of the housing is filled with a heavy fluid. The drag of the fluid tends to prevent any sharp jerks on the handle from being transmitted to the spring under test. A compression spring inside the hollow rack returns it to the top position when the handle is released.

The dial indicator rides on the spring attachment plate fastened on top of the rack.

The present set of weights is equal to 5 lbs. of spring force but the beam supports and knife edges will stand more weight if necessary. A maximum spring length of 12″ may be accommodated. The beam and pointer with balancing stud extends 15½″ over-all.

For **calibration work** it has been found convenient to unbalance the beam by shifting the counterweight a slight amount so that there will be a few ounces of pull on the spring when the pointer is zeroed. This insures positive contact between the hooks and the ends of the springs. The beam support is then positioned so that the pointer will be at zero by use of the slide and the screw adjustment. A weight is placed on the pan and the gear drive is used to stretch the spring so as to return the pointer to zero. The downward rack travel is read on the dial indicator.

For checking a number of springs at one load, the desired rack travel is set in by adjusting the stops to limit the handle motion. For each spring, the pointer is zeroed with no weight on the pan, the proper weight is applied and the handle pulled down. Limits can be put on the amount that the pointer can be off of zero and be within the tolerance set for the springs.

The arrangement for moving the beam to zero the pointer (and to compensate for differences in the lengths of the springs) permits the rack travel setting and the dial indicator to remain undisturbed. The customary procedure is to use a fixed beam, which means that the lower end of the spring where the deflection is set in must be adjusted for each new spring. At the same time, the dial indicator or stops for spring deflection must be readjusted, which is somewhat time-consuming if done accurately.

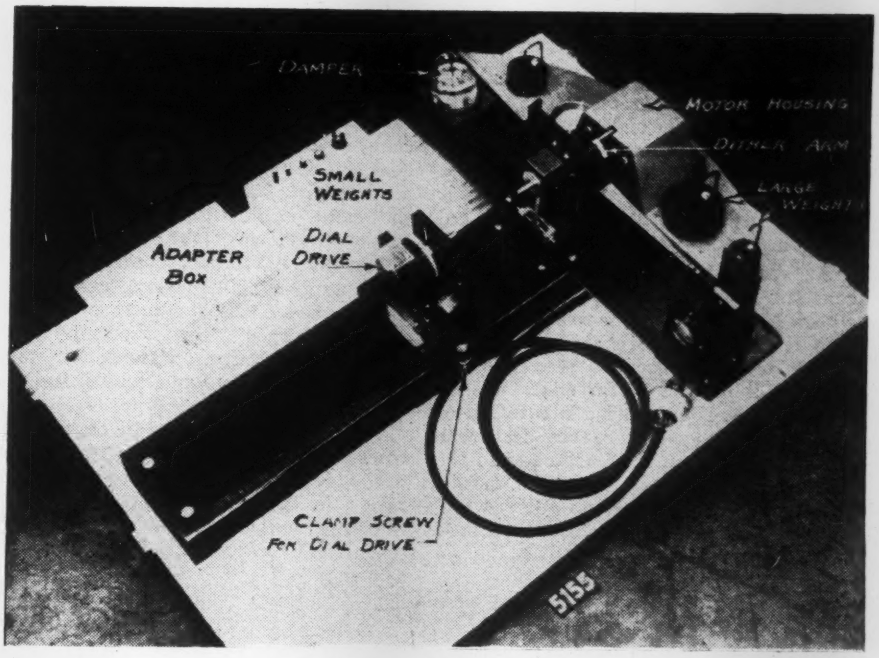

Fig. 2

It will be found in practice that determination of spring deflections to an accuracy greater than 0.002″ is difficult. The deflections of the supports, hysteresis in the spring, and other factors, all conspire to prevent reproducing results consistently to better than 0.002″. This does not mean, however, that more accurate results cannot be obtained in special cases.

Torsion Spring Tester

The torsion spring tester is shown in Fig. 2. In a similar fashion to the extension spring tester, a beam with weights is used to supply the torque load for the springs. The deflection is read off of the dial drive, which is graduated to read to 0.2 degree of rotation. The spring under test is fastened to the two shafts by means of adapters which may be stored in the covered box shown on the side of the base. The small weights are located in the block next to the adapter box. The larger weights are on a shelf in the back of the beam structure. The smallest weight is 0.010 lb. and the largest 1.000 lb. These weights are hung from the notches machined in the top of the beam from a point 2″ from the pivot line out to 6″ from the pivot line. The notches are spaced every 0.100″. However, a spacing of one every half-inch or inch should be sufficient for most purposes.

In contrast with the other spring tester, ball bearings instead of knife edges were used to provide adequate restraint for all directions of load including thrust. Ordinarily, even the best ball bearings have too much frictional torque for use at low loads. It has been found through tests in the Laboratory that a good selected bearing can have a no-load torque of 0.001 pound-inch. Since there are two bearings effectively supporting the beam, a frictional torque of 0.002 pound-inch can be expected. Supposing it was desired to measure the deflection of a spring with an applied load of .02 pound-inch (0.01 pound at the 2″ notch). The bearing friction will reduce this to an effective value of 0.018 pound-inch, giving an error of 10 percent in spring loading. This is far from sufficiently accurate.

To reduce the bearing friction, it has been found helpful to "dither" the bearings, *i.e.*, to rapidly oscillate through a small angle one of the races about the other. The oscillation speed is not critical but will depend upon the inertia of the beam and the maximum friction of the bearings. In this case, a small synchronous motor was used to oscillate the beam support crank shaft at 1800 cycles a minute through the use of small crank arms and connecting member. The arm length on the motor shaft was made small in comparison to that on the beam support shaft to give an oscillation amplitude of ±10°. The motor is enclosed by the housing at the rear of the beam support. When the dither is used, a sensitivity of 0.00015 pound-inch per division on the scale is obtained.

Even dithering at 1800 cycles a minute did not prevent the occurrence of small instantaneous seizures between the balls, retainer and races in the ball bearings. Consequently, the beam would not always stand still with the dither operating but would occasionally start swinging. A small amount of damping was introduced by suspending a light ¾″ diameter brass disk in a bottle of instrument oil. This effectively stops all intermittent disturbances of the beam.

The beam pointer is made of a ¼″ wide piece of spring steel 0.015″ thick. The edges are black; the top and bottom sides are painted with different colors so that one can tell which way the parallax is acting. The scale graduations are 0.015″ wide and spaced 1/16″ apart.

As shown in Fig. 2, the dial drive consists essentially of a worm and wheel. A 4-thread worm was used to obtain a minimum of backlash. A ratio of 20 to 1 was used so that the fine drum dial on the worm shaft has 90 graduations, representing a rotation of 18° of the wheel. A coarse dial with 20 graduations on it is attached to the shaft of the wheel. Since the torque to be applied may be in either direction, clockwise or counter-clockwise, two sets of numbers had to be put on for reading each direction. To avoid inconveniently large dials, a system of numbering alternately for each direction in red and white was employed at each fifth graduation. Thus, in proceeding along one direction from zero, the numbers read as follows: 5 (white), 80 (red), 15 (white), 70 (red), etc.

The dial drive assembly can be shifted back and forth along the machined base casting to accommodate springs up to 12″ in length. Two clamps, one on each side, whose lower portions engage in slots on the sides of the base, serve to anchor the drive assembly in place.

TORQUE METER

In testing various mechanisms, it sometimes is necessary to gain some idea of the shaft loads. With large equipment, strain gages can be applied to the shafts to give a stress indication from which the torque can be determined. There are also the so-called torque wrenches which are essentially cantilever beams. These, however, are cumbersome and not sufficiently accurate. Accordingly, the rotary type instrument shown in Fig. 3 was designed. Flat coiled springs, usually in pairs, are used to provide the torque.

There may be some difference in the calibration between the case where the spring is being wound up and the case where it is opening up. Consequently, a pair of springs mounted in an opposing fashion are used to get the same calibration, without regard to the direction of the torque.

The dial of the instrument is graduated to give 200 divisions per revolution. However, the springs are designed to work over ± ½ revolution; therefore one half of the graduations and numbers have been colored white and the other half red.

The instrument is 3″ in over-all diameter. At present, its maximum range is 3 pound-inches; the lowest range is 0.5 pound-inch. This means that one division on the dial will represent values from 0.03 to 0.005 pound-inch. Whatever the range, the parts of the instrument are all the same except for the springs. The instrument consists essentially of a back piece, front piece, two springs and a knob. These parts may be seen in Fig. 3.

The springs are made of heat-treated beryllium copper to insure reliability and accuracy. The innermost coil is fastened by solder to a slit collet whose bore is undersize by several thousandths of an inch from the shaft that it fits on. The back piece has a clamp type hub with two clamp screws and a shaft on the other side of the flange. The dial pointer fastens to the flange, the springs are pressed on the shaft, and the front piece is carried on a ball-bearing fitting on the front end of the shaft and held on by a screw and washer.

The front piece carries the dial and an extension arm for clamping on to the outer end of the springs. The arm rides in a radial slot and can be shifted to accommodate springs of various diameters. On the front piece there is also a clutch or collet arrangement: a partly-threaded tapered 4-jaw split tube extension, on which the knob screws to tighten the jaws to gr[illegible]e insert shaft. This was found [illegible]fficient prevent high torque load[illegible]n slippi the shaft; so four set sc[illegible]were ad ed on the knob. When tig[illegible]ng dow each screw should bear o[illegible]aw.

A peak torque indic[illegible] in t shape of a wire ring w[illegible]ojecti end to catch the pointer, m[illegible] notic in Fig. 3. This is used in[illegible]s whe the shaft may seize and [illegible] free suddenly. The wire end [illegible] carri around with the pointer to [illegible]e ma mum reading position and [illegible]ft the Since both sides of the instr[illegible]ent w take shafts, it can be use[illegible] to che shaft outputs of small moto[illegible]. In th case, a Strobotac is used to read t pointer position.

STROBOTAC CALIBRATION

Experience in the Laboratory has i dicated that the dial reading of a Str

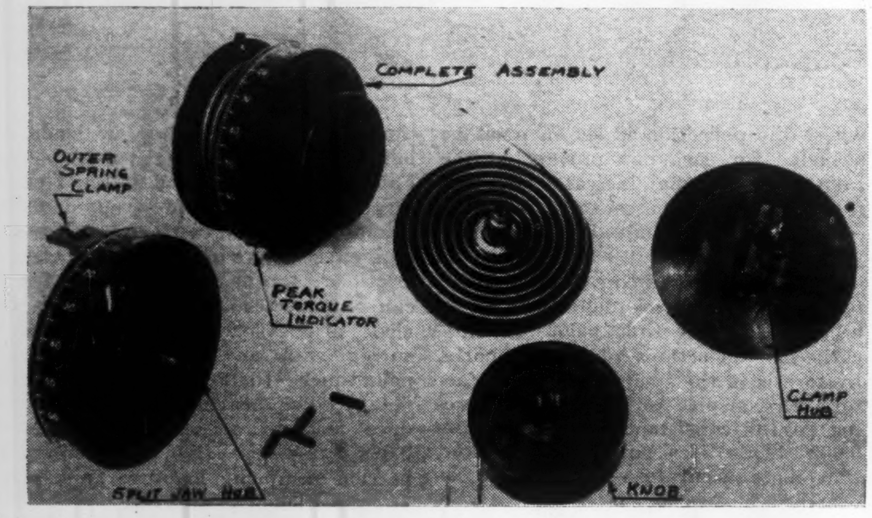

Fig. 3

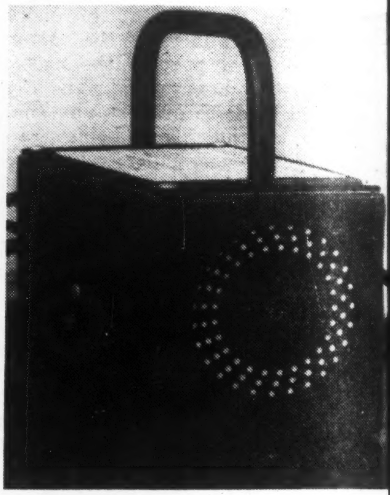

Fig. 4

botac may be off by several percent f speeds not near the calibration poin of 900 and 3600 cycles per minute. often is necessary to determine th speed of electric gyro rotors quite a curately. The speed range is in th neighborhood of 23,500 r.p.m. which of course, is out of range of the Str botac. However, the half speed of 11 750 r.p.m. can be used for the check The 60-cycle reed is not sufficiently use ful at this speed for calibrating, so re course must be had to other means.

The simplest thing to do is to tak a synchronous motor (1800 r.p.m.) an attach to its shaft a prepared dis bearing a number of dots in a circle the numbers so calculated that whe the shaft rotates at 1800 r.p.m. an the Strobotac is adjusted to 11,75 r.p.m., the dots will seem to stand still Ordinarily, the dial reading will no correspond with the proper setting; s two things may be done: either as sume that the error in the reading stays constant in the region of tha speed or use the calibrating adjust ments to bring the dial reading to 11, 750 r.p.m. It has been customary to use the latter procedure at the Laboratory

The calibrator shown in Fig. 4 consists of a box containing the motor with disk showing on one end. Three rows of dots are used to cover a small range of speeds. The rows contain respectively 25, 26 and 27 dots, corresponding to the useful points of 11250, 11700 and 12150 r.p.m. on the Strobotac. This adequately covers the range of gyroscope rotor speeds which can be encountered. The cord wraps around the outside of the box when not in use and is kept up by the two hooks on the side.

Since the dots actually pass at the rate of 45000, 46800 and 48600 a minute in front of any fixed point, the Strobotac will stop them at any of the sub-harmonic speeds. However, it is so unlikely that a Strobotac set at 11750 r.p.m. may actually be flashing 9000 r.p.m. (and cause the dots to stop on the 1/5 harmonic) that no confusion should result.

The accuracy of this speed check is, of course, dependent on the stability of the 60-cycle frequency of the main power line. For instance, if the power line frequency is found to vary between 59.94 and 59.98 cycles per second during a test, it is still possible to determine the rotor speed within 30 r.p.m. (about ⅛ percent accuracy).

BALL-BEARING TESTER

The requirements for precision instrument ball bearings are such that in many cases only selected bearings are used, with specifications on their frictional torque, freedom from jamming up, radial play, end play, and angular freedom between the two races. Freedom from friction is of such importance on occasions that each bearing in the assembly is individually tested before use. The bearing tester shown in Fig. 5 is used to check the frictional torque of small bearings under a radial load. The tester is self-contained with folding sides to form a box with a handle on the cover for carrying purposes. The cover is not shown in Fig. 5.

The tester is of the pendulous type for simplicity and reliability. The bearings are inserted into adapter bushings which in turn fit inside a hollow cylindrical weight made of a sintered tungsten material with a density of about twice that of steel. This special material was used to get the desired weight with the smallest outer diameter so as to minimize the moment of inertia of the assembly. The moment of inertia of the weight and adapter bushing tends to cover up any small torque peaks which may be present during the course of a revolution of the bearing under test. Bearing torque shows up as deflections of the pointer from the zero at the center of the dial when the inner bearing race is rotated. The inertia of the weight will tend to prevent this deflection. Thus, small torque peaks may not be strong enough to start the weight and attached pointer moving; and will be hidden.

In operation, the bearing adapter and weight with pointer are assembled and then slid on a support shaft. Two switches (which may be noticed in the top of the box) operate a small synchronous motor to drive the shaft at 10 r.p.m. One switch will cause the motor to run one way and the other will reverse the direction of rotation. The final gear (visible in Fig. 5) may be disconnected from the drive so that the shaft may be rotated manually by a knob on the end of the shaft. To disconnect, a pin, whose head is seen immediately in front of the gear, is pulled out. The motor drive is used to standardize the rotational speeds so as to have comparable results at all times. Otherwise, the operator manually turning the shaft quickly may get better results than the one turning it slowly. Here again it is a matter of the inertia of the weight: the effectiveness of the inertia in covering up small torque peaks will increase with rotational speed.

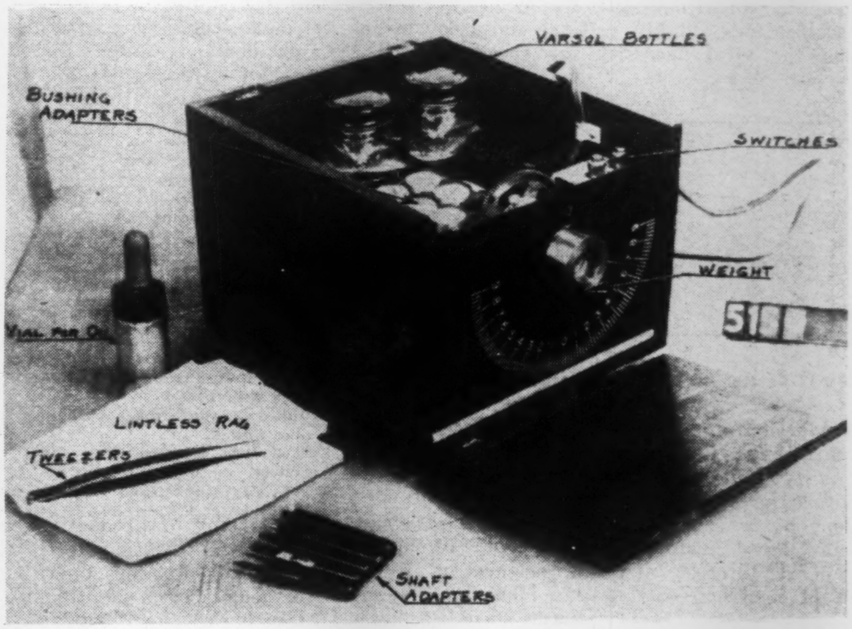

Fig. 5

To accommodate various sizes of bearings the shaft drive has interchangeable steel adapters, a few of which may be seen in the front of the tester. They are contained in a rack behind the motor. The large end of an adapter fits into a hollow drive shaft and is slit so that a spring effect is produced to insure a frictional drive. The duralumin bushing adapters for the bearings may be seen mounted on a shelf fitting over the motor. The radial loading weight is carried on a separate shelf to be seen in back of the switches.

Two pointers, one of duralumin, the other of brass, are provided. They fit into a short reamed hole in the weight. Since their weights are different, the sensitivity of the tester will vary with them. At present, the calculated maximum torque from the pointer is 6 gram-cm. for a deflection reading of 90° (9 on the dial).

Other bearing friction testers are available but most of them check the bearing in the unloaded condition. Inasmuch as our concern was for applications where the bearing did have some loading while in operation, it was decided to use the weight for the purpose of providing a loading which would simulate more closely the operating conditions. The weight applies an 8-oz. radial load on the bearing. Since only the single bearing under test is used, some care in construction is necessary to make sure that the weight is balanced on the bearing to avoid any cocking effects from unbalance.

The two bottles in the back of the box, the vial with attached dropper on the cap, the cloth and tweezers, are all used for cleaning and handling of the bearings before test. They fit into compartments inside the box. It is well-known that a small atomized stream of solvent followed by a clean, dry air jet is one of the best means of cleaning and drying a bearing. However, these facilities are not always available. The procedure then is to mount the inner race of the bearing on the tweezers and immerse it in a bottle of solvent, gently rotating it by rubbing the outer race against the sides of the bottle. One of the bottles is used for the first and the other for the final wash. A wire mesh inserted near the top of each bottle prevents any parts from dropping down to the bottom of the bottle where sludge settles. The large bottles allow use of more solvent—which means that a larger

Continued on page 712

A New Method of Sorting Steels and Other Alloys by Employing the Triboelectric Properties of Metals

By **ANTONY DOSCHEK**, Development Engineer, Farmers Engineering & Mfg. Co., Pittsburgh 21, Pen

UNAVOIDABLE mix-ups encountered in steel and metals production during the war years have focused considerable technological attention on rapid electrical methods for sorting and identifying metallic parts in the various stages of their manufacture. Hugely increased tonnages, conservation of alloying constituents, closer chemical specifications, highly critical end-uses and the vital necessity for speed in production and delivery to exact requirements have posed sorting and quality control problems which heretofore have not been dreamed of except by a few. However, such problems have perforce now become of general interest and the science of rapid electrical sorting and identification of metals is fast becoming an individual and highly important adjunct to metallurgy.

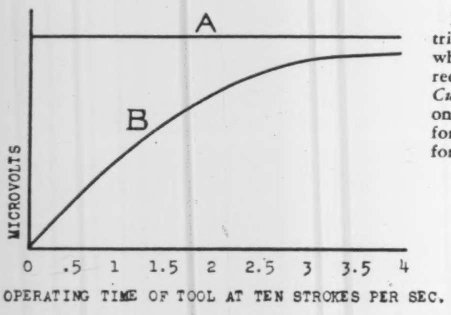

Fig. 1. *Curve A*—Instantaneous triboelectric voltage developed when two unlike specimens are reciprocated against each other. *Curve B*—Effect of this voltage on the microvoltmeter. Restoring force of instrument lengthens time for saturation reading.

At present the emphasis is placed upon speed and meeting exact specifications for critical end-uses; the future will shift this emphasis somewhat toward the economies realized, as a result of quality control, in a strongly competitive field.

Stock and parts mix-ups are a common occurrence in metals plants and purely accidental causes of these can be legion. Billets are often mixed when a stack is upset and then spills over, upsetting adjacent stacks of the same size billets. Paint and tag indicia are obliterated during conditioning, reheating for rolling and heat treating operations. These must be replaced after each such operation; with the possibility of errors occurring through remarking. Stamped indicia are rolled-out and often distorted beyond recognition.

In machine shops and fabricators' plants the chances of mix-ups are even greater because of "stock replacement." Such mix-ups occur, for example, when bars which have been correctly identified by painted ends are removed from the stock racks for machining and then the overage is replaced—after the painted ends have been cut off! An overage of this kind can and should be used up, but the waste and risk involved is far greater than the value of the material if unidentified material is worked into finished parts.

In view of these uncertainties and the great variety of alloys being produced, it is essential that personnel responsible for their disposition and distribution be equipped with rapid means to make certain identification tests. A decided advantage in efficiency and economy of production can be realized if identification tests are applied after each working operation. Older methods of identification, namely, the spark and bead tests, chemical spot tests, etch tests and various physical tests, are sometimes quite useful in the solution of a specific problem but are generally too limited in their scope and application. All too often, these tests require skill and interpretive experience.

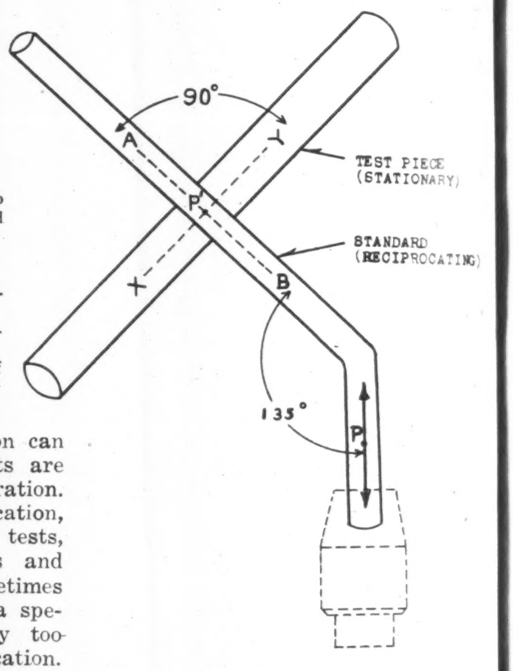

Fig. 2. Contact arrangement to minimize scoring and localized cold working.
P—Center of contact.
P'—Point of contact.
At full upward stroke, *B* coincides with *Y*.
At full downward stroke, *A* coincides with *X*.
Dashed lines represent lines of contact.

The need for making check analysis tests on metal pieces of a large variety of compositions, shapes, and sizes and at so many different stages in their manufacture has stimulated the invention and development of an electrical sorting method which would prove to be extremely versatile in its application as regards the chemical compositions to be sorted and which could be readily mastered by the personnel in the inspection department. Such a method would also need to be rapid and be capable of being embodied into a rugged and completely portable instrument. Although portability would seem to be a secondary issue, it was considered important because of the dangers of further mix-ups occurring when material must be moved to the sorting equipment.

Toward these ends the triboelectric effect in metals was chosen as the operating principle of the method. The triboelectric effect is observed through the electric current which is generated when two metallurgically dissimilar metals are caused to move in contact with each other. If the two metals are identical, no current is generated and the fact of their identity is thus manifest. Triboelectric voltage values range from a fraction of a microvolt to several millivolts, depending upon the chemical compositions of the metals or alloys in triboelectric union. The friction necessary to produce triboelectrification in dissimilar metals need not be great enough to rupture the surfaces on which tests are made and the disposition of the pieces being tested, *i. e.*, whether or not they are in mechanical and electrical contact with other unlike metals, has no bearing whatever on the validity of the tests.

Except for lightning, triboelectrification is probably the oldest electrical phenomenon observed by man. Thales of Miletus found, some 600 B. C., that amber, when rubbed against a chemically dissimilar substance, acquired the property of attracting light objects. This property, possessed by most substances to a greater or lesser degree, is now known to be imparted by a redistribution of electrons on the interfaces of the chemically dissimilar substances which are brought into intimate contact and then moved so as to generate some friction between them. Triboelectric charges on substances of a dielectric nature tend to remain at the surfaces when the contacting materials are taken apart and thus result in a static charge, the magnitude of which can be determined by means of an electroscope[1] but, if the triboelectrically charged materials are electrical conductors connected together by a third conductor, some of the redistributed electrons will flow through the connecting conductor and thus constitute a measurable electrical current in the conductor.

The method herein described makes use of this phenomenon in sorting two or more alloys of different chemical compositions. Since heat treatment of most alloys also cause chemical differences to take place within the alloys, the method can sometimes be used to distinguish between heat-treated and hot-worked alloys produced from the same heat or melt although it is generally much more responsive to elemental differences in chemistry than to differences in the formation of chemical compounds and stresses as produced by heat treatment.

Many experiments conducted on the triboelectrification of metals show this phenomenon to be unique in several respects. It can be demonstrated, for example, that a deflection resulting from the triboelectrification of any two dissimilar metals is not changed either in magnitude or polarity when the test is repeated while the specimens are submerged in cold water. A lubricant is used on the surface of the standard during a routine test to minimize the chances of scoring, because scoring has been found to cause an error in indication when it occurs; but if the specimens do not score each other during frictional contact, the sense or magnitude of the deflection produced is not altered whether the specimens present a dry surface or a lubricated surface or whether an abrasive such as valve grinding compound is applied to their interfaces. The principal caution to be observed, it was found, is that the surfaces of the material being tested do not contain any scale or other oxide, since scale is triboelectrically very powerful with respect to metal, and that the surface is representative of the general chemistry and metallurgical constitution of the material.

Furthermore, the manner of creating a moving contact between two metallic pieces in order to produce triboelectrification is not critical, provided that triboelectrification be carried on until the measuring instrument indicates a saturation potential. That is to say, any two combinations of dissimilar metals will reach a point of maximum triboelectric potential beyond which no increase in the manner, speed or pressure of the moving contact between them will increase or reverse the polarity of the potential. For the purposes of this investigation, therefore, a commercially available reciprocating tool of approximately ⅜" stroke length was used to provide the moving contact between the standard bar and the work or "unknown" pieces.

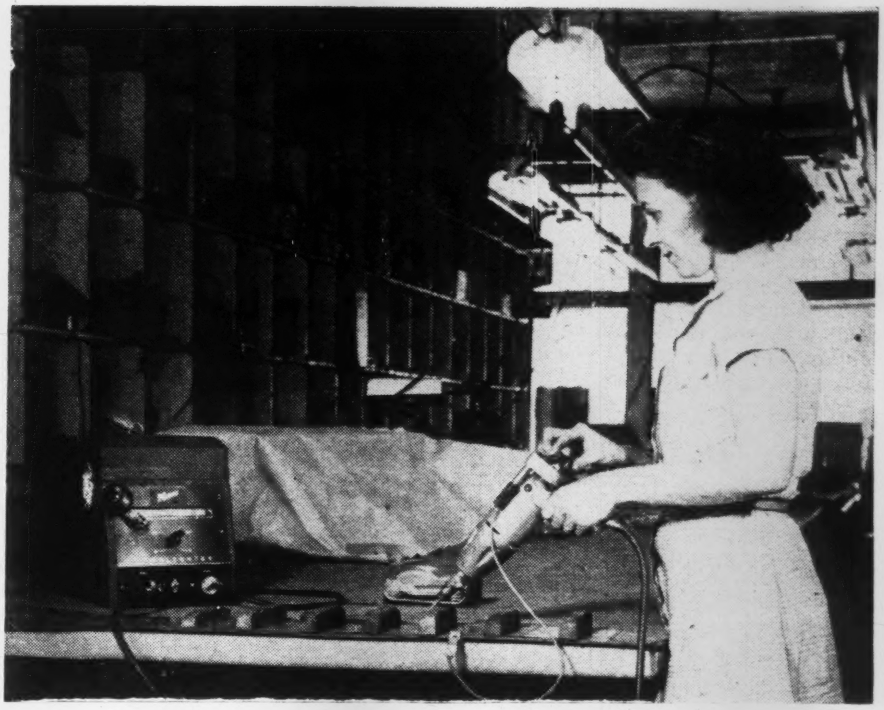

Fig. 3. Testing Cast Coupon Bars. When testing parts such as castings, they may be placed on a copper strip to which the clip lead from the tool is attached.

An electronic circuit was designed to control the frequency of reciprocation as well as the total operating time of the instrument and to provide a biasing potential used to balance out any parasitic or thermoelectric currents. The method consists of affixing a "known" or standard bar into the chuck of the tool and placing this bar into contact with the "unknown" or piece to be tested. The "unknown" is electrically connected into the measuring circuit by means of a simple spring clip connector. The scale of a microvoltmeter is then observed and, if the indication is other than zero, the parasitic reading is balanced out by means of a control mounted upon the reciprocating tool. The test initiating switch is also mounted upon the tool and this is depressed to start the reciprocating motion. Further controls are provided which limit the operation time of the tool, its frequency of motion and the sensitivity of the microvoltmeter. After reciprocation stops, the reading of the microvoltmeter is taken. This reading then serves as an indication of the identity of the standard bar with respect to the "unknown," if the reading was found to be substantially zero, or the degree of dissimilarity existing between the standard and the "unknown," depending upon whether the indication was electrically "positive" or "negative" and also upon its magnitude.

Sorting at the rate of approximately thirty pieces a minute may be carried out by means of the triboelectric method and its operation, when the method is embodied in an instrument, is simple enough for almost anyone to manage.

Because it can be assumed that some heat is generated at the sliding point of contact between the specimens during reciprocation, experiments were conducted to study the interrelation of the triboelectric effect and the thermoelectric effect. During the course of these experiments, several combinations of steels and other alloys were discovered which produced deflections opposite in polarity to those obtained by application of heat to the junction of the two specimens (thermoelectric effect). In some cases, heating the junction of two known dissimilar specimens by means of an electric arc produced a very small thermoelectric effect while simple reciprocation of the specimens against each other showed a large triboelectric effect.

It is interesting to note that mercury may be used as one member of a triboelectric couple. Moving a dissimilar metal through a pool of mercury causes a triboelectric current to be generated. If two specimens are connected to separate leads of a microvoltmeter and then moved simultaneously through a pool of mercury, the mercury will act as a standard metal and at the same time as an electrical conductor between the two specimens, causing a triboelectric current to be generated if the two specimens are chemically dissimilar.

Further experiments along these lines disclosed the rather startling and unexpected phenomenon of the selective power of certain metals, when used as standards, with respect to other chemically unrelated metals. As an illustration, a 0.50% Mn Ni-Cr alloy and a 1.75% Mn Ni-Cr alloy show a potential of approximately 40 microvolts

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(1) Richards. *Physical Review,* Vol. 22, 1923, page 122.

(2) Shaw & Hanstock. *Proceedings Royal Society,* Vol. 128, 1930, page 474.

A New Method of Detecting and Locating INSULATION FAULTS

By E. F. HARTER and G. L. MOSES, Generator Eng'g Dep't, Westinghouse Electric Corp., East Pittsburgh, Pa.

TESTING of insulation between turns, coils, layers and phases is as important as the testing of ground insulation, but it presents special problems and requires radically different test apparatus. A new method for such testing has been devised recently and test equipment developed which simplifies and speeds up the detection and location of winding faults. The new method can be used also on complete windings for simultaneously testing ground insulation.

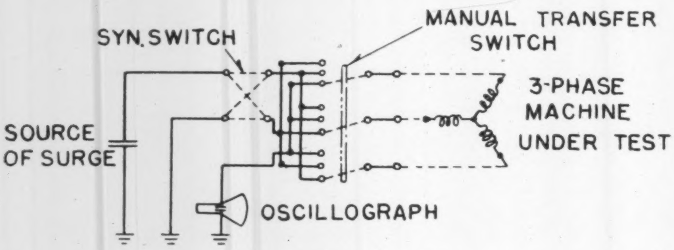


Fig. 1. Three-phase test.

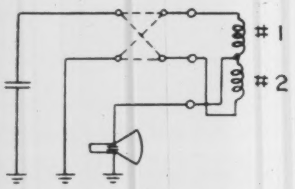


Fig. 2. Two-coil comparison test.

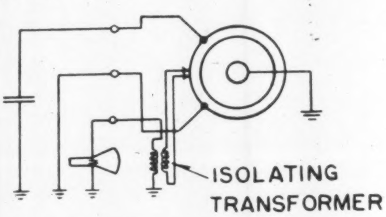


Fig. 3. Armature comparison test.

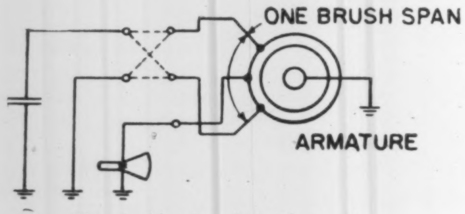


Fig. 4. Armature bar-to-bar test.

The most common form of the test equipment consists of a surge generator which is alternately connected to two winding terminals every other cycle (of the 60-cycle power supply) by a synchronous double-throw two-pole switch. Thus surge voltages are propagated through the winding, first in one direction and then in the other. Their effect is observed on a cathode-ray oscilloscope so that two parts of the winding (or two identical coils) can be compared. When the two windings are symmetrical, the images in the cathode-ray oscilloscope are identical and appear as a single image. Any fault, such as shorted turns, affects the two waves differently and produces two images on the oscilloscope. The shape of the waves can be interpreted as indicating the nature of the fault. This device gives comparative information regarding two parts of a winding or two coils while applying a surge voltage which is propagated through the winding.

This device is suitable for testing a wide variety of coils and apparatus. Multi-turn armature and stator coils can be tested for turn insulation. Magnet coils also can be tested between turns and layers. Three-phase windings are readily tested by the original scheme unless there are a large number of parallel circuits. On such windings a modified scheme using exploring coils is available which not only detects faults but locates the exact position.

The surge tester was first designed for testing small three-phase induction motors. Three output terminals were provided for connection to the three terminals of the test motor. The surge generator and the oscilloscope could be connected to any combination of the three motor terminals by means of a manual transfer switch built into the tester as shown in the diagram, Fig. 1. Nearly all small three-phase motors can be tested for weak insulation and faults in the manner illustrated by this diagram.

Individual coils, single-phase motors, or other pieces having no inherent

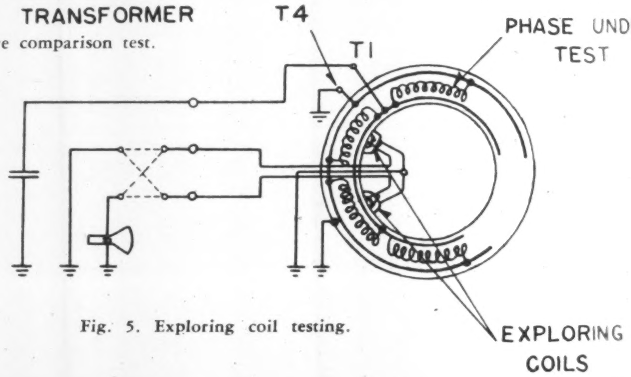
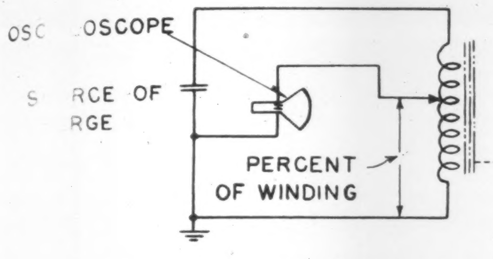
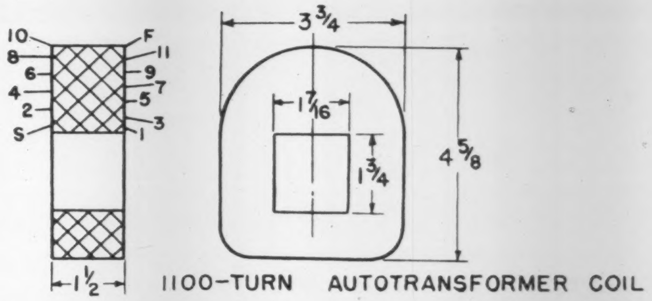


Fig. 5. Exploring coil testing.

Fig. 6. Comparison surge tester in use on large stator winding with many parallel circuits.



7. Method of measuring surge peaks.



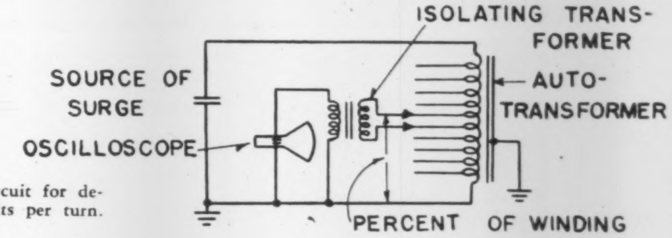


Fig. 8. Circuit for determining volts per turn.

three-phase symmetry may be tested in pairs as shown in Fig. 2. Here one coil or winding of a type is used as a standard for comparison testing of other similar pieces. This method was applied to all coils and miscellaneous windings tested. A comparison method was also found useful in d-c. armature testing. The surge was applied to the commutator at points one brush span apart with a third contact midway between to form the midpoint for the two-winding comparison scheme. Fig. 3 illustrates this simple adaptation.

The surge for this test is produced by the discharge of a condenser which produces a high rate of voltage rise. Because of this high rate of rise a relatively high test voltage can be applied to most types of windings and coils. This applied voltage is distributed with reasonable uniformity throughout the turns of most windings. However, it is desirable to observe the distribution of voltage on various types of apparatus. This was done by two methods shown in Figs. 7 and 8. The results of such tests are shown in curves, Figs. 9 and 10. From these it can be seen that this tester produces a reasonable uniform voltage distribution on most types of windings except transformers with iron cores where there may be a higher gradient on the end turns.

The new method is an excellent tool for the engineer, manufacturer and repairman. Its field of usefulness will undoubtedly be rapidly extended in the near future as it offers numerous advantages, such as:

1. Readily adjustable voltage which does not exceed the selected value.

2. All control is simple and easy and connections to the coils or apparatus are not complicated.

3. It is flexible in application and may be used for testing wide variety of equipment.

4. Voltage stress to ground is a known and controlled value.

5. The surge voltage has a wavefront approximately that of switching and lightning surges, which cause most turn-insulation failures in service.

6. Grounded or shorted coils may be located to the exact slot without breaking connections or puncturing insulation.

7. D-c. armatures may be tested without placing them in a special lathe.

8. The cathode-ray oscilloscope provides a constant view of the test voltage and its effect on the winding.

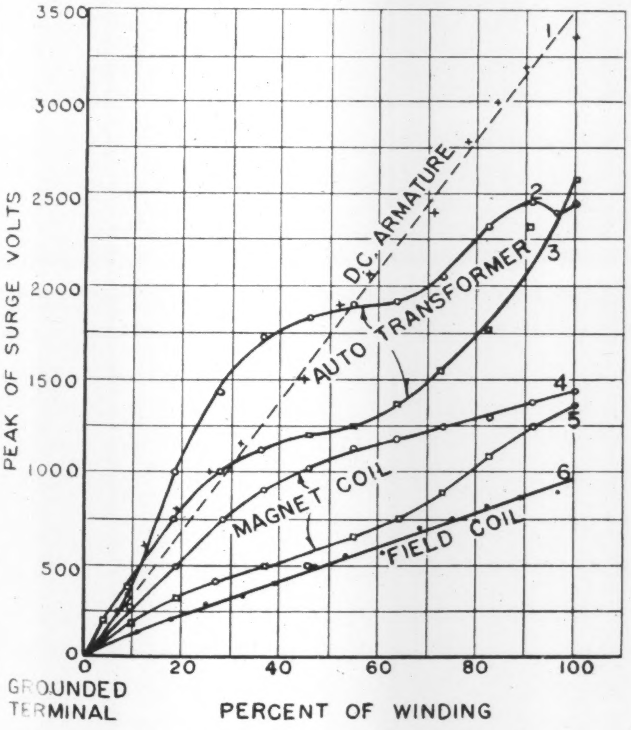


Fig. 9. Surge-voltage distribution in four types of coils.
Curve 1. Large d-c. armature
Curve 2. 1100-turn autotransformer—surge to inner lead
Curve 3. 1100-turn autotransformer—surge to outer lead
Curve 4. 35000-turn magnet coil—surge to inner lead
Curve 5. 35000-turn magnet coil—surge to outer lead

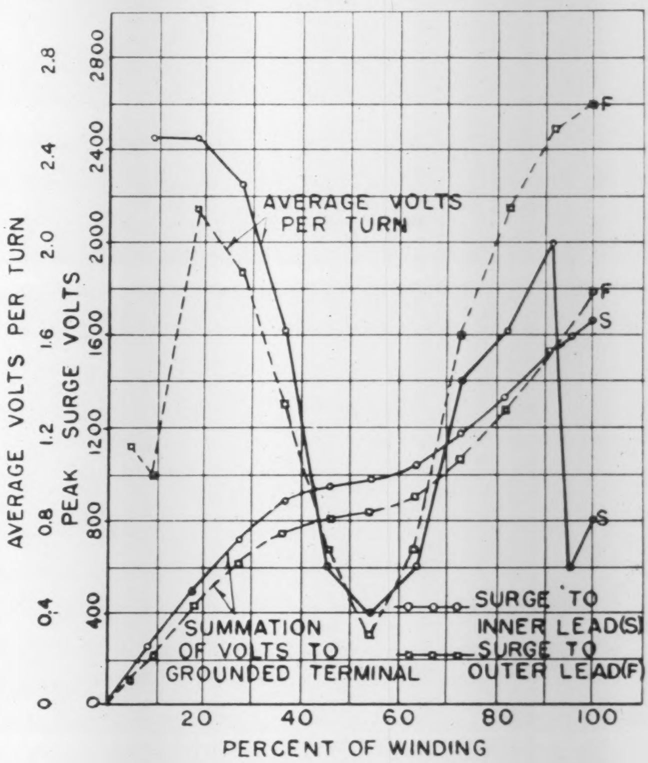
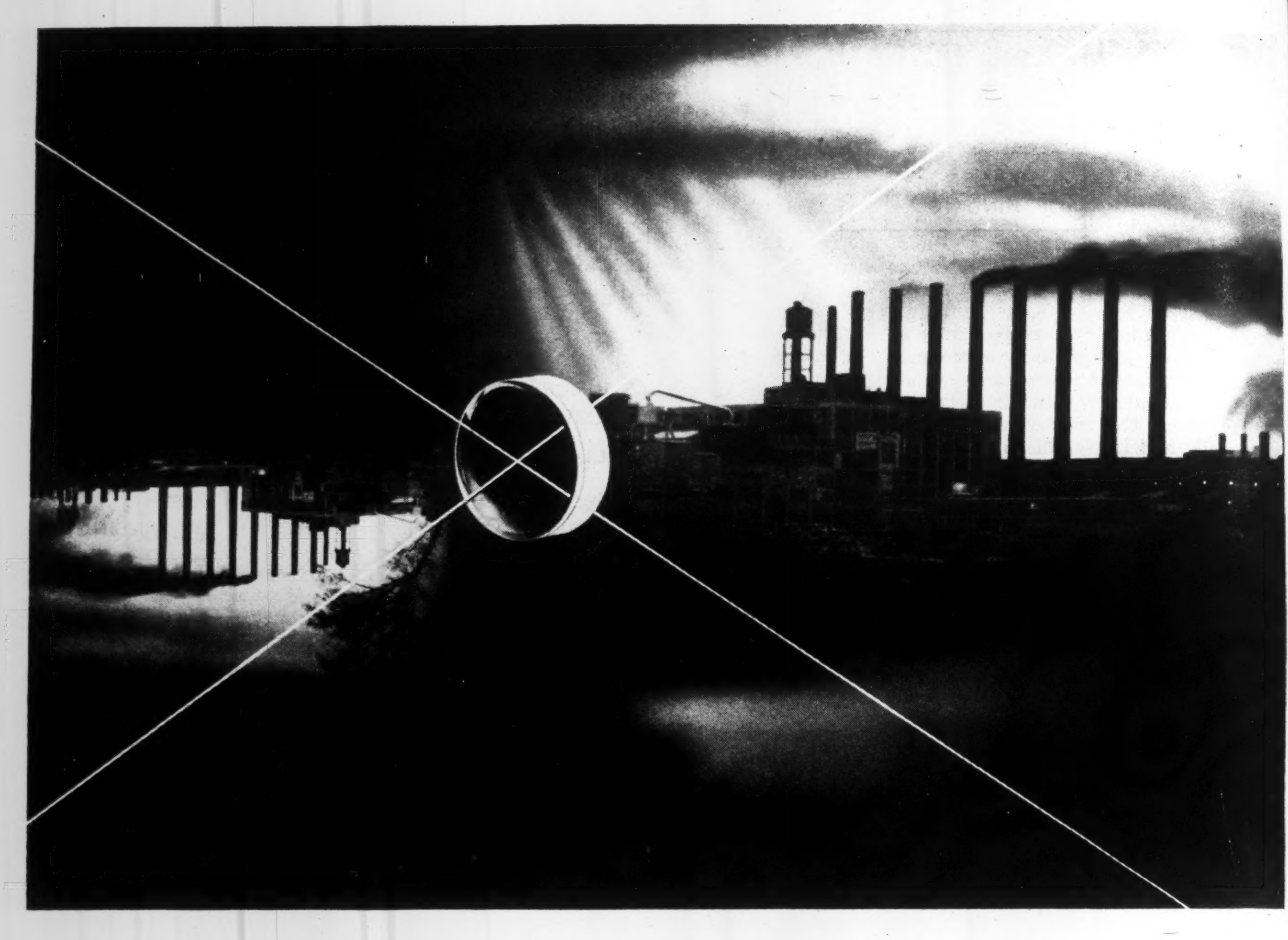


Fig. 10. Average volts per turn in an autotransformer calculated from measurements obtained as in Fig. 8.



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LENSES . . . PRISMS . . . FLATS . . . REFLECTORS

ELECTRIC GAGING METHODS

For Strain, Movement, Pressure and Vibration

By HOWARD C. ROBERTS, Research Staff, Association of American Railroads, Chicago, Ill.

XIV. CALIBRATION-CHECKING CIRCUITS

Calibration-checking circuits are not in any sense either substitutes for or improvements on calibrating devices. Their function is to afford an immediate and convenient check on the sensitivity of a gaging circuit which has already been calibrated by other means. To a limited extent, too, such circuits can be utilized as means of transferring or retaining calibration data. They can be employed with either amplified or non-amplified gaging systems.

The most straightforward and usually the most satisfactory calibration-checking circuits are those which produce a change in the same circuit parameter as does the primary element itself. As a rule it is best if this change is produced in the same portion (or a symmetrical portion) of the gaging circuit. Frequently, however, practical considerations prohibit the fulfilment of this second requirement.

With a variable-capacitance primary element, a calibration-checking device may be provided simply by connecting an auxiliary capacitor in parallel with the primary element. This auxiliary capacitor may be a fixed unit having a known value, or a variable capacitor which can be set to any desired value. Either arrangement provides known increments of capacitance which may be added to the capacitance of the primary element by operating a switch. Since the capacitance of the primary element is seldom greater than perhaps 100 micromicrofafads, while its change during operation may be no more than 10 $\mu\mu$fd, the auxiliary calibration-checking capacitor must obviously be less than 10 $\mu\mu$fd, and its value must be constant and known to a high degree of accuracy. This requirement immediately imposes serious constructional difficulties, since the leads employed to connect the auxiliary capacitor may have as great a capacitance as does the capacitor itself, and since this lead capacitance is ordinarily quite inconstant. Error from this cause can be avoided by suitable expedients in design of the circuits.

With variable-capacitance gaging systems employing the difference in frequencies between two electrically resonant circuits (see Figs. 7 to 25 in Part I), it often is most satisfactory to apply the calibration-checking circuit to the nominally fixed-frequency oscillator. The fixed-frequency oscillator is usually installed in a case with other control and power circuits, and is compact and constructed with short rigid leads, while the variable-frequency oscillating circuit must be installed at the point of measurement in most cases, with connecting leads which may be long and having relatively high and variable capacitance. The most convenient arrangement with such a circuit is to provide an auxiliary capacitor which serves at the same time as a calibration-check device and as a device to adjust the circuit against frequency drift. Thus, if through gradual change in the value of any circuit component, or through slow changes in the capacitance of the primary element, it becomes necessary to adjust the two oscillating circuits again to resonance, the auxiliary capacitor is used for this adjustment. At the same time, since the auxiliary capacitor is variable and is graduated in known increments of capacitance, the effect of a known increment of capacitance on the deflection of the indicating instrument may be noted, and thus a check made on the calibration of the entire circuit. The elements of such a variable-capacitance gaging system, with the auxiliary capacitor for adjustment and calibration-checking, are shown in Fig. 12.

Variable-inductance gaging circuits may be provided with calibration-checking circuits in much the same manner as are the variable-capacitance circuits. The most widely used variable-inductance circuits employ the primary elements as components of symmetrical (and often unity-ratio) bridge circuits, excited by alternating current. Under some conditions a satisfactory check can be provided by means of an auxiliary resistance unit which can be switched into or out of the circuit. In the general case, however, the only safe method for such a check is to provide a separate inductance element, having the same ratio of reactance to resistance (or Q) as the primary measuring element, which can be connected at will in series with the primary element. The use of such an element will maintain both phase and amplitude balance for the bridge circuit. An extremely satisfactory method, entailing only slight inconvenience, is to provide a separate primary element, incorporating a micrometer screw, which can be connected into the circuit in place of the measuring element by the operation of a switch. With this element, it is possible at any time to re-calibrate the system; or for rapid checking the auxiliary unit can be set to any desired value and then used in the manner described above.

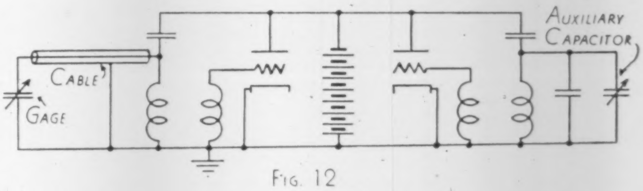

FIG. 12

Permanently-installed variable-inductance elements (especially for measuring movements of relatively large magnitude) can often be so constructed as to permit at will changes of air gap of fixed amount. This provision makes available an accurate and convenient method for checking the calibration of the system.

Variable-resistance gaging circuits are less easily provided with calibration-checking devices than are most variable-capacitance or variable-inductance systems, simply because the percentage variation of the operating parameter is ordinarily far less in the variable-resistance circuit than in either of the other two. This limitation does not occur in moving-contact or slide-wire elements, but in any system employing strain-sensitive or pressure-sensitive primary elements it amounts to a serious difficulty.

The auxiliary element which must be introduced into a variable-resistance gaging circuit must be an essentially pure resistance element, and its value must depend both upon the total resistance of the primary element and upon its strain sensitivity (or pressure sensitivity). Occasionally, the effect of temperature must also be considered. And since most of the presently-used variable-resistance gaging elements now in use have resistances of the order of 100 ohms and change in resistance by only a small fraction of one ohm in operation, the resistance of a series auxiliary resistor must be small—of the same order, in fact, as the resistance of the leads employed in connecting it—and not much greater than the resistance of the switching device employed to introduce it into the circuit.

Practical considerations make it virtually necessary to employ parallel auxiliary elements as calibrating devices for strain-sensitive gaging systems, unless it is possible to introduce an entire new bridge circuit as a calibration-checking device for an amplifier or a recording unit. Even then, the same difficulties appear with regard to the required magnitude for the auxiliary element—its value will differ for each value of resistance of the primary element, and for each value of strain-sensitivity for the primary element. Unlike either capacitive or inductive primary elements, the total impedance of the primary element cannot be altered by any adjustment made upon it.

In Fig. 13 a suitable circuit for a calibration-checking circuit for a resistance-type gaging circuit is shown. One of the three resistors R'_1, R'_2, and R'_3 may be placed in parallel with either R_3 or R_4 of the bridge circuit itself; Sw_1 does this. The appropriate resistor is selected by Sw_2. Thus, if the system is to be used for measuring strain, this auxiliary circuit provides three check-points in the tension direction, and three similar points in the direction of compression.

The resistance values of the three auxiliary resistors of Fig. 13 must be computed for the value of gage resistance and for the gage factor employed. For example, if R_3 and R_4 each have a value of 120 ohms, and the strain-sensitivity of R_4 (the gage) is 2.0, the auxiliary resistor to be applied to cause an 0.05% change in the effective value of R_4 will have a value of about 120,000 ohms. Obviously, the resistances of switches and leads will have little effect when they appear in series with resistances of so high a value. And since the amount of unbalance of the bridge circuit is extremely small under these circumstances, the error introduced by the apparent indiscriminate switching of the auxiliary resistors into any arm of the bridge circuit is quite negligible.

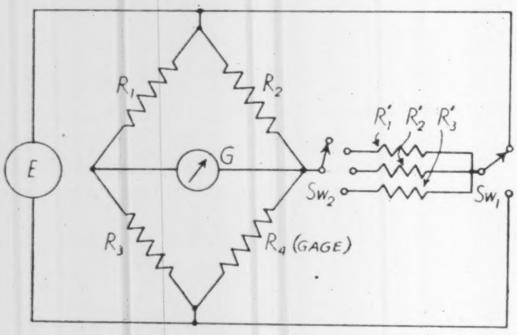

FIG. 13

In practice, it is ordinarily found more satisfactory to install three resistors of fixed values at R'_1, R'_2, and R'_3, then to determine by computation the effect of each of these for every resistance value and strain-sensitivity value for the primary elements to be used with the circuit.

But it is also necessary to consider the effect of capacitance upon the balance condition of the bridge circuit, if it is excited by alternating current: in amplified systems a-c. excitation is customary. This difficulty may be entirely avoided by careful mechanical design. For example, the location of the switching devices should be such as always to keep the lead capacitance constant. It is good practice to install all four arms of the resistance bridge circuit at or close to the point of measurement if long leads must be used; if this is done, the auxiliary calibrating resistors can be installed within the case of the amplifier, with short leads and consequent avoidance of lead-capacitance error.

With photoelectric and piezoelectric gaging systems it is hardly possible to employ any straightforward or general method as a calibration-check device. The primary elements are of extremely high impedance, and their operation is dependent to a considerable degree on their mechanical installation. In general, however, their calibration-checking devices are better mechanical than electrical, and must be designed to be applied to the particular installation.

XV. OSCILLOGRAPHS

The most generally applicable instrument for recording the output of several instruments simultaneously is the oscillograph. Available in a number of different mechanical forms, and employing several different operating principles, this instrument is capable of recording simultaneously and on the same strip of paper the intelligence from a number of different sources; together with time indications, identifying marks for the different records and, if desired, the calibration data for the several circuits. There are also available automatic oscillographs, which do not operate continuously, but wait for the incidence of some phenomenon, record it, then wait for the next incident to be recorded. The most widely used oscillographs, however, are of the manually-initiated type, which record during the entire period of their operation.

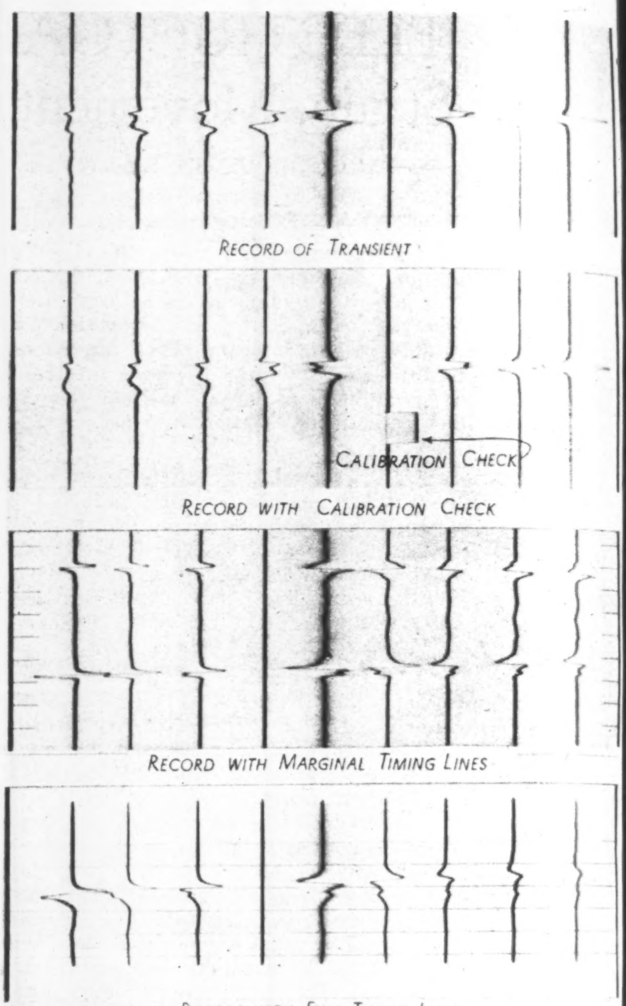

Fig. 14. Typical Oscillographic Records. (Original recording paper width, ten inches.)

Up to recent years the most popular form of multi-element oscillograph for recording purposes was the string type, or the Einthoven oscillograph. Its use at this time is confined almost entirely to medical applications—encephalography. Even there it seems likely that other forms will entirely replace the Einthoven type before many more years have passed. For low-frequency applications, however, it is an extremely useful instrument. Its principal disavantages in operation are these: it produces records in white lines on a dark ground, which is less easy on the observer's eyes than dark lines on a white ground; there is some danger of tangling the strings in operation, and it is less convenient to replace one string in a heap of several strings than to replace one galvanometer in a group of several in a moving-mirror type oscillograph. The operating principle of the string-type galvanometer is indicated in Fig. 184 of Part I.

Most presently-used oscillographs are of the moving-mirror types; for low frequencies and high sensitivities (in terms of current) the moving-coil or d'Arsonval type is most popular, while for the higher frequencies (with correspond y lower sensitivities) the bifilar or Duddell type is emp d. These two types are illustrated in Fig. 188 of Par the moving-magnet type, shown there at *B*, is now li used excepting as a null instrument for a-c. bridge cuits.

Typ oscillographic records are shown in Fig. 14; each s section illustrates some outstanding feature of the in ment employed to make these records. The first section isplays a record of a transient physical effect, record with a group of nine accelerometers. (One of the nine uments is not operating.) No timing marks or other ntifications are included in this record. The next record of a similar transient; it has, however, on one trace alibrating deflection. (This particular calibration-checki device, it should be noted, does not make a dynamic check, though it is applied to an acceleration-sensitive system. It is therefore a check on all other parts of the system, but not of the acceleration-sensitive primary element.)

The third and fourth records shown are like the first, with the exception that they contain timing marks; the third record has marginal indications at tenth-second intervals, while the fourth has timing lines extending entirely across the record—also at tenth-second intervals. It is possible at will to produce timing lines, either marginal or full width, at hundredth-second intervals; in this instance the tenth-second lines are made heavier than the hundredth-second lines, and the twentieth-second lines intermediate in intensity. All these records were taken on photographic paper ten inches wide, moving at a speed of approximately three inches per second.

It should be noted that any of the electromagnetic oscillographs which will be described will produce records very much like these. Most of them are available with a number of different types of galvanometers, with a range of paper (or film) drive speeds, and with as many built-in auxiliaries (such as timing devices, titling devices, and control devices) as may be desired.

Typical of the highly-adaptable modern magnetic oscillograph is the one shown in the photograph, Fig. 15. This instrument was designed for general-purpose use, and contains every facility consistent with size and weight, while retaining sufficient ruggedness for field use. It may be procured with 6, 12, or 24 magnetic galvanometers of any of several types, fitted to different applications. Its records are made on photographic film or paper, of any width desired up to ten inches; records may be made as long as desired without exceeding the length of the standard roll of paper—200 feet. Quick-change gears provide a range of paper speeds from 1/3 to 40 inches per second in 15 steps. Timing lines of any desired type may be applied at will. Footage of the paper record is automatically photographed on each record; titles containing other information may be added when desired. Remote control of the oscillograph is possible, as is automatic control of record length. All galvanometer circuits are fitted with on-off switches, protective fuses and attenuator units. Thermostatic control of temperature is also provided. The weight of an instrument of this type will be from 100 to 150 pounds, and its total volume from 3 to 4 cubic feet.

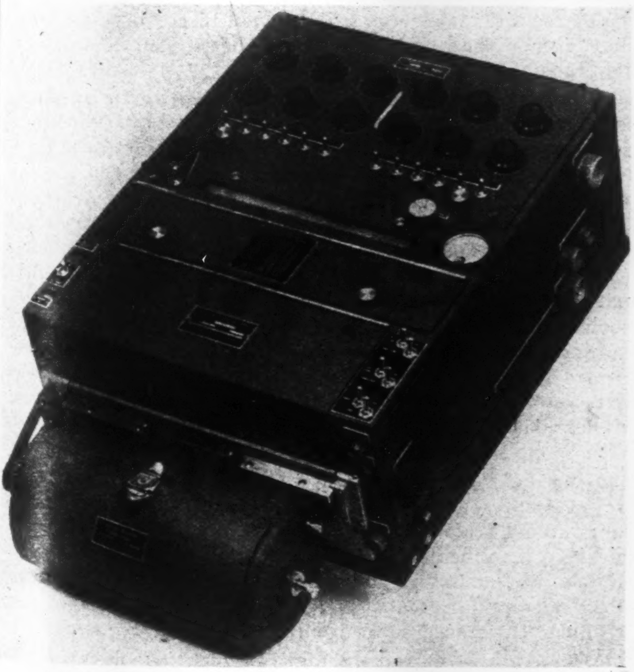

Fig. 15. General-purpose Multi-element Magnetic Oscillograph. *(Courtesy Hathaway Instrument Co.)*

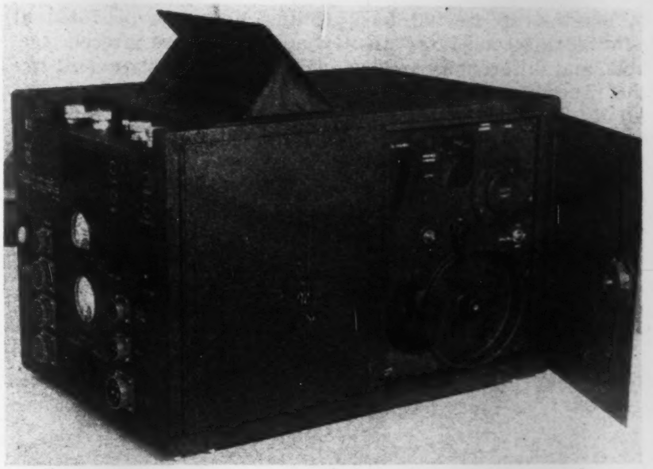

Fig. 16. Light-weight Magnetic Oscillograph. *(Courtesy Consolidated Engineering Corp.)*

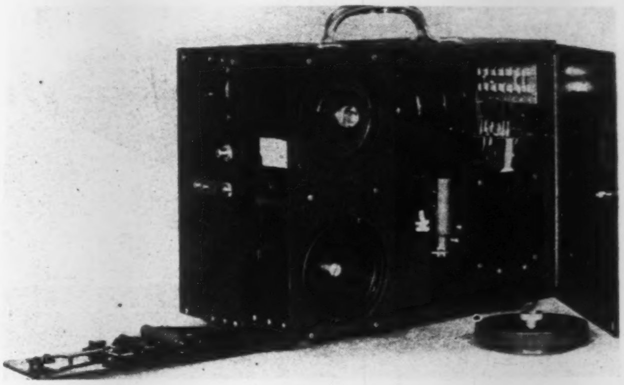

Fig. 17. Portable or Aircraft Oscillograph. *(Courtesy Heiland Research Corp.)*

Many of the features of an instrument such as that just described are not needed for the intended application; and for many uses a simpler instrument, containing only part of the numerous features of the complete instrument, may be more satisfactory. Such an oscillograph is shown in Fig. 16. This instrument takes photographic paper 8 inches wide, and records with as many as 14 galvanometers. It has available only three paper speeds, or six on special arrangement. The same provisions with regard to timing devices, titling, record numbering, and interchangeability of galvanometers are available. The weight, however, is only about 70 pounds and the bulk about 2½ cubic feet. Such an oscillograph is better suited for installations where extremely limited space and weight can be accommodated, but is of course less adaptable for general use.

Even more compact than the instrument shown in Fig. 16, and with correspondingly fewer conveniences, is the instrument shown in Fig. 17. This oscillograph contains six galvanometers and records upon paper two inches wide and in lengths up to 100 feet; timing lines are provided at hundredth-second intervals. Galvanometers are interchangeable, and different types are available. This instrument, like the preceding one, employs a single magnet assembly for all its galvanometers, instead of a series of separate galvanometer each complete in itself. This construction may be seen through the open door of the instrument in the photo. The instrument weighs 22 lbs. alone, and approximately 40 lbs. complete with its batteries and paper stock. It should be noted that the photograph shows the instrument with its battery case attached; it is ready to operate as it stands. Its bulk is about one-half cubic foot.

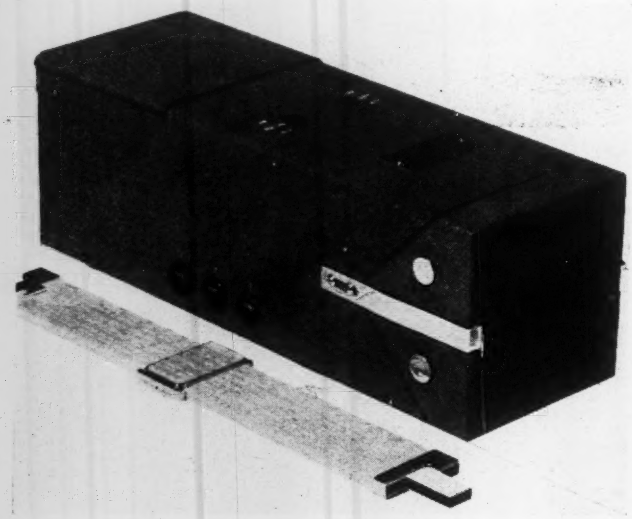

Fig. 18. Miniature Multi-element Magnetic Oscillograph. *(Courtesy General Electric Co.)*

An instrument such as the one just described has been deliberately designed to provide the maximum in operating convenience and output with the smallest practicable size and weight. Even smaller instruments can be constructed, with, of course, necessary limitations of functions and convenience.

In Fig. 18 is shown what is perhaps the smallest multi-element magnetic oscillograph now available. It weighs only twelve pounds and its volume is less than ⅙ cubic foot, yet it can record the intelligence from as many as six sources on a strip of paper 3½ inches wide and 20 feet long. The galvanometers are separate and interchangeable. Three paper speeds, 0.24 in./sec., 0.6 in./sec., and 1.2 in./sec., are available through the use of change gears. A slightly larger instrument, employing ten galvanometers and recording on 6-in. paper, is also available. In both these oscillographs, it must be recognized that only the necessary basic components have been included in the interest of obtaining the great reduction in size and weight. These oscillographs show the opportunities for design where only the *basic* elements are required.

It must be remembered that the four instruments just described do not represent a complete list. They do illustrate the range available in size, ability, convenience and applicability. Other oscillographs are available; there is hardly an application for which a suitable instrument is not in existence.

Certain applications requiring only low-frequency response from the galvanometers, and yet not requiring response to steady currents, can well be accommodated by one of the types of direct-writing (or ink-writing) oscillographs. These instruments have the advantage of producing a record by means of an inked pen—or by a heated stylus on a wax-coated paper, or by an electrically-charged stylus on an electrosensitive paper. Their record is thus immediately available, and with none of the inconvenience involved in the photographic development of a film or paper photographic record. Such instruments are well suited to the medical field, and to certain industrial applications.

The "galvanometer" elements employed in direct-writing oscillographs are most often piezoelectric elements coupled to the pens through light mechanical linkages. They are thus potential-sensitive elements, and not current-sensitive; and they have quite high impedances. Amplifiers are required for almost all applications. The upper limit of frequency response is ordinarily set by the characteristics of the galvanometer element, and is of the order of 100 cycles per second. The lower limit usually is set by the amplifier characteristics, and ordinarily does not go below 1 cycle per second. The piezoelectric crystals do not respond satisfactorily to direct current—to steady potentials.

A typical direct-writing oscillograph is shown in Figs. 19 and 20. This is a piezoelectric type instrument, and can be procured with as many as eight simultaneously-operating pens. Paper speeds may be suited to the application. The frequency response of these elements covers the range between about 1 cycle per second and 100 cycles per second; the maximum amplitude available on the record is approximately two inches—1" excursion in either direction. The piezoelectric elements will respond to frequencies somewhat higher than the upper limit listed, but at reduced amplitude.

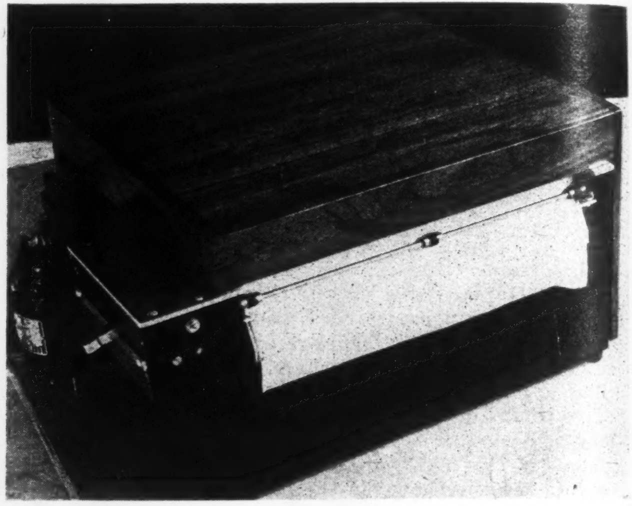

Fig. 19. Multi-element Direct-writing Oscillograph: External View. *(Courtesy Offner Electronics, Inc.)*

Piezoelectric recording units, like piezoelectric primary elements, usually employ Rochelle salt crystals for their high sensitivity, and these crystals are subject to damage if their temperature reaches about 125°F. If the crystal is subjected to steady potentials, some non-elastic deformation takes place and the element may be damaged. To avoid these disadvantages, and to provide a unit which could respond to steady potentials, electromagnetic ink-writing units are available. Their general performance is much the same as that of the piezoelectric elements; excepting that they can operate at zero frequency. They require sufficient current for their actuation to make a current amplifier for each galvanometer a necessity for most applications.

These direct-writing oscillographs have a wide and increasing field of application, and are rapidly being improved At present, their principal disadvantages, aside from their limited frequency response, are the necessity for considerable amplification, and the fact that the records they produce are distorted, and their deflections must be read along a circular scale. Neither of these disadvantages precludes their successful application in many instances.

For recording extremely high frequencies, none of the instruments thus far described is satisfactory. The upper limit of faithful frequency response for the direct-writing oscillographs is perhaps 200 cycles per second—quite low. The upper limit for the bifilar magnetic oscillograph is about 12,500 and some difficulty is experienced in reaching this figure. Frequencies higher than these can at present be successfully recorded only with the cathode-ray oscillograph.

It is entirely possible to produce satisfactory records by employing a stationary camera to photograph the pattern produced on the screen of an ordinary laboratory-type cathode-ray oscilloscope; better records can often be produced, and records of non-repetitive as well as repetitive wave-forms, if a moving-film camera is used with such an oscilloscope. Such equipment combinations are too often makeshift, however, and involve too much difficulty and inconvenience in operation to permit their use for any except emergency or short-time work. More refined arrangements are far more satisfactory; they are more accurate as well as more convenient.

For the satisfactory delineation and reproduction of non-repetitive wave-forms the most difficult requirement to fulfill is the production of a satisfactory time-base or other horizontal-axis indication. The linear time base incorporated in the ordinary laboratory oscilloscope is satisfactory only if the frequency of the repetition is nearly constant. Next in importance is the establishment of a sufficiently intense electron beam to make possible the high writing speeds that may be required. The second of these requirements has been taken care of by the manufacturers of cathode-ray tubes; the first requires the application of some device sensitive to the movement being studied—or to such other magnitude as is to be recorded along the horizontal axis. This movement-sensitive or position-sensitive device provides a potential suitable for deflecting the luminous spot of the cathode-ray tube along the horizontal axis in accordance with the phenomenon being studied. A stationary camera film is then used, and the photographed pattern is actually a record of two variables plotted one against the other — a true *x-y* recording. One of the two variables may be time, or it may be any other desired magnitude. In this respect the cathode-ray oscillograph can be applied in a more flexible manner than can the other previously described instruments.

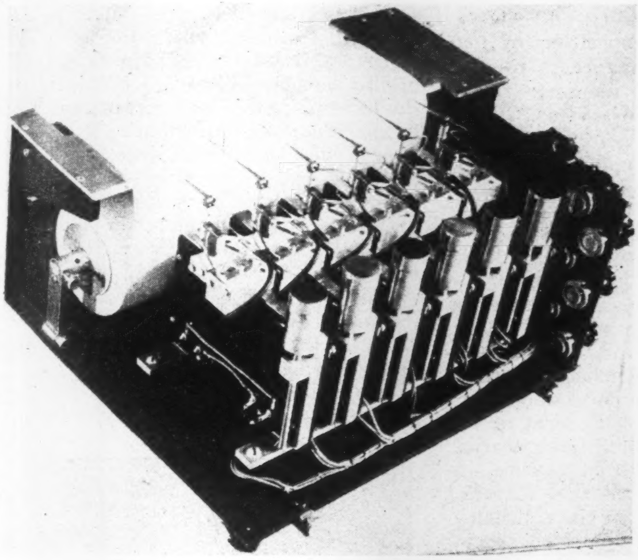

Fig. 20. Multi-element Direct-writing Oscillograph; Internal View Showing Construction. *(Courtesy Offner Electronics, Inc.)*

A number of devices have been produced by which the horizontal axis mentioned can be provided; they operate on the basic principles previously described. Among the most widely applied recording systems of this sort are those designed to record cylinder pressure against piston position (for the study of combustion characteristics in internal-combustion motors) and those for recording force (or stress against strain) for the study of the characteristics of materials.

Multi-element cathode-ray oscillographs, recording a number of separate traces simultaneously against a time axis, have had a rather limited application up to this time, primarily because of the necessary bulk, weight and circuit complications involved in their construction. Such instruments are, however, available, and it is to be expected that their use will expand rapidly in the near future.

In Fig. 21 is shown a convenient form of multi-element cathode-ray oscillograph. This instrument records four traces simultaneously on 35-millimeter film, and covers the range of frequencies from 0 to 40,000 cycles per second —the response being down only 10% at 40,000 cycles. Its weight is about 100 pounds, and its bulk about two cubic feet. Moving film is employed, with four speeds available through quick-change gears; the highest speed available is 40 inches per second. The instrument thus records one other variable against time on each channel.

The instrument just described represents an attempt to cover virtually all the frequencies encountered in any ordinary work with a single instrument; it seems probable that the attempt has been successful. There are few instances in which frequencies higher than perhaps 20,000 cycles per second occur at the point of application of a pick-up—they may be produced at the point of application of an impact, but the high frequencies are attenuated extremely rapidly, and are not ordinarily detectable a few inches away. In liquids and gases—in the study of detonation, for example —extremely high frequencies are occasionally encountered. In all cases, the problem of making a primary element sensitive to these extremely high mechanical frequencies, and of carrying the electrical signals undistorted over the connecting cables, provides considerable difficulty. It seems entirely safe to say that in the present state of the art, we have recording devices in advance of the other components of the complete system—although lacking, perhaps, in convenience of operation.

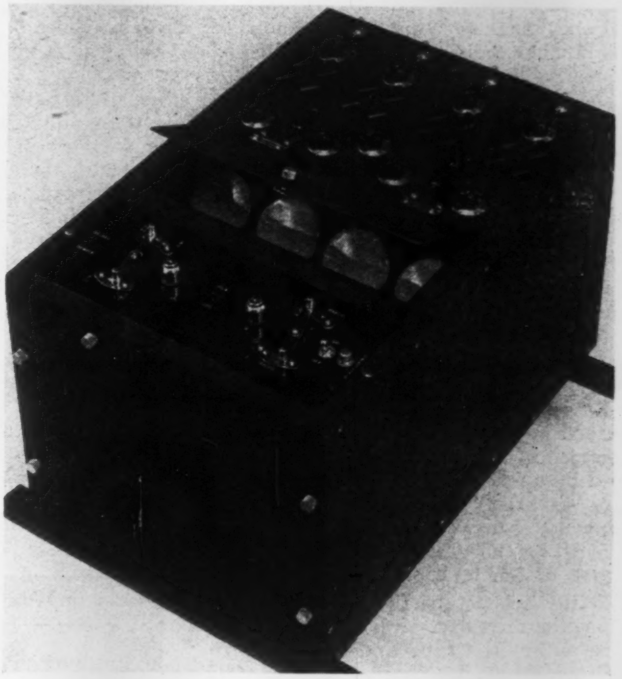

Fig. 21. Multi-element Recording Cathode-ray Oscillograph. *(Courtesy Heiland Research Corp.)*

No description is given here of the several types of recording potentiometers, voltmeters and milliammeters

Continued on page 706

INSTRUMENTS ON THE MARCH

X-rays and Multiplier-ammeter Afford New Means of Chemical Analysis, G-E. Research Chemists Find

SCHENECTADY, N. Y.—Shooting a beam of x-rays through an unknown chemical substance to see how much of the radiation is absorbed is a new and rapid means of identifying the elements of which the material is made. That this method, which can be used with gases, liquids or solids, will find extensive application is indicated by studies in the General Electric Research Laboratory by Dr. Herman A. Liebhafsky and Dr. E. H. Winslow.

"X-rays are intimately related to the inner atom," explained Dr. Leibhafsky, "so they furnish a means of counting the number and indicating the kinds of atoms by which they are being absorbed. To a very good first approximation, the count is unaffected by whether the atoms are free or have combined to form molecules of any sort whatsoever; or by whether the sample is hot or cold, solid, liquid or gaseous. Again to a good approximation, an oxygen atom will have the same absorption for x-rays be it free, or in the oxygen molecule, or in liquid water, ice, or steam, or in sugar or in sand. A tool capable of doing this is bound to be potentially interesting to the chemist."

X-ray absorption as an analytical method is made practicable by a photoelectric x-ray intensity meter developed by another G-E Research Laboratory scientist, H. Millard Smith. The invisible x-rays activate a phosphor painted on the glass envelope of a phototube of the multiplier type.

With such a tube the light from the phosphor falls first on a sensitized surface within the tube and electrons are emitted from it. These electrons fall on a second surface from which still more electrons, in larger quantities, are discharged. They fall on a third surface and the yield is still further increased. Then even more stages are used. The electrons are multiplied and those from the last stage constitute an electric current which can be amplified and measured. In this way, amounts of light with energy equal to a ten-billionth of a watt can be measured easily and accurately.

The photoelectric instrument can measure weak-intensity x-rays and also can detect slight variations in their intensity. For example, if the x-rays are passed through a pile of 100 sheets of paper, the addition or removal of a single sheet produces a noticeable effect.

In the analytical method developed by Drs. Liebhafsky and Winslow (which has thus far only been set up experimentally) the solid or liquid sample is placed in a glass cell ¾" in diameter and 6" long. For gases a two-foot cell is employed. The cell is in a vertical position above the x-ray tube and a narrow pencil of the rays is sent upwards through it. Comparisons are made of the absorption of the rays with and without the sample. Filters of various metals can be placed in the x-ray beam to secure radiation of different wave-lengths.

Dr. Liebhafsky says that chemical problems vary so greatly that it is difficult to predict the particular applications which this new method of analysis is likely to have. However, enough work has already been done in the G-E Research Laboratory to show that for certain types of problems it will have clear advantages over older methods. These are now being studied and they will be reported later.

Unique Giant Spectrometer Speeds Chemical Analysis

EAST PITTSBURGH, Pa. — Questions on chemical composition of materials, of vital importance to the oil, chemical and plastics industries, have always been difficult to answer. To analyze an oil sample by ordinary chemical methods, for example, may take a crew of six technicians eight hours and the results are not always as accurate as desired. The infrared spectroscope, with its invisible beam of light, "fingerprints" each component of the material, and performs the job many times faster and more accurately than any previous method. A specially-designed version of this most modern of spectroscopes has been developed by Dr. Donald K. Coles, young chemist at the Westinghouse Research Laboratories, who is shown at work in the adjoining photograph. To analyze a material —either liquid, solid, or in solution— Dr. Coles places a sample in a special holder and directs through it a beam of infrared light which he produces by heating a silicon-carbide rod to an incandescent glow. Highly-polished mirrors and special prisms guide the light along a thirty-foot-long, zigzag path to highly sensitive receivers that convert the light into electrical current, amplify it, and record the information by means of a special strip-chart recorder. From the peaks and dips on the recorder chart, Dr. Coles can tell what materials are present in the sample, how much of each, the amount of impurities, and other vital facts.

The infrared spectroscope depends for its speed and accuracy of analysis on the fact that molecules vibrate at certain characteristic frequencies as do atoms and electrons in producing visible light, but more "slowly"—though

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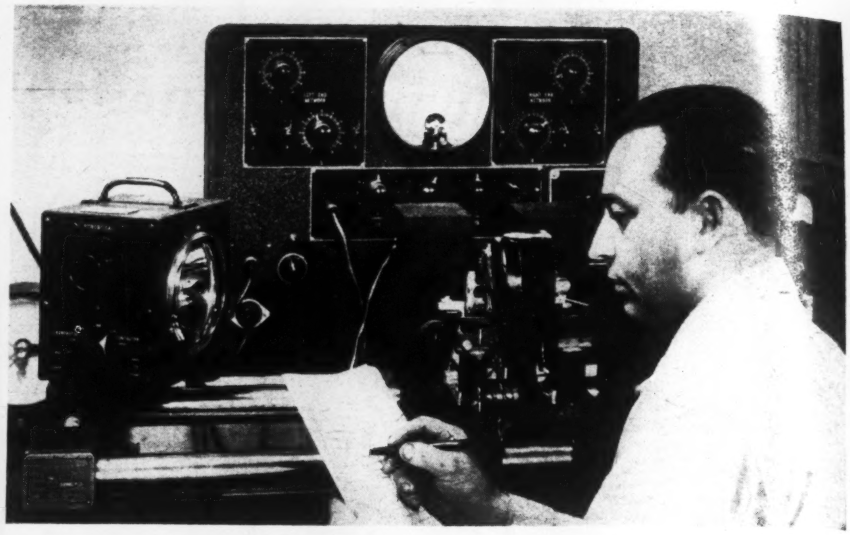
the slowness is relative, for the frequencies of the order of mega-megacycles. The spectroscope ferrets out the different frequencies by gradually "tuning" the frequency of the infrared beam throughout the infrared spectrum—just as you slowly tune your radio set throughout a portion of the radio-waves spectrum when "trying for distance." The principle is similar to that of astronomical or metallurgical spectroscopes but instead of a photographic plate there is an extremely sensitive infrared pick-up before which the infrared spectrum is made to pass. At the same time, the chart of the synchronized recorder is made to travel in exact relation to the wave-lengths, so that peaks and dips are traced by the pen to represent the absorption bands of the various molecules in the material under study. This synchronized autographic arrangement is similar to that of a recording color analyzer. Dr. Coles thus identifies the material as accurately as fingerprints reveal human identity.



Stroboscopic Light Was Used for Testing Famous Norden Bombsight

EMPORIUM, Pa.—Stroboscopic light played an important part in the exact balancing of rotating parts in the Norden Bombsight where tolerances were kept within 20 millionths of an inch. Timed light flashes permitted precise determination of rotating speeds and visual study of imbalance during laboratory tests. In the photograph herewith, light flashes were produced by a strobotron tube manufactured by Sylvania Electric.

Also shown in the photograph is a technician in the laboratory of the Victor Adding Machine Company using a General Radio Strobotac and a Gisholt Dynetric Balancer.

Norden Bombsights, costing several hundred dollars more than an automobile, had two basic parts: a stabilizer that piloted the plane automatically during the bombing run; and a sight which included telescope, gyro and computer. They were the result of the teamwork of many manufacturers who made, tested, and assembled components and those who manufactured specialized scientific test equipment without which exact standards and interchangeable parts would have been impossible.

Electrical Robot Slashes Equation-solving Time

EAST PITTSBURGH, Pa.—An electrical robot that can conquer in a few days intricate mathematical equations that would take years through ordinary calculation, is now helping engineers of the Westinghouse Electric Corp. in the solution of complex problems. Developed by Dr. Gilbert D. McCann and Harry E. Criner, of the Westinghouse engineering staff, the apparatus uses electricity flowing through circuit elements to perform all the computations and to write the answer with an electron beam on a fluorescent screen.

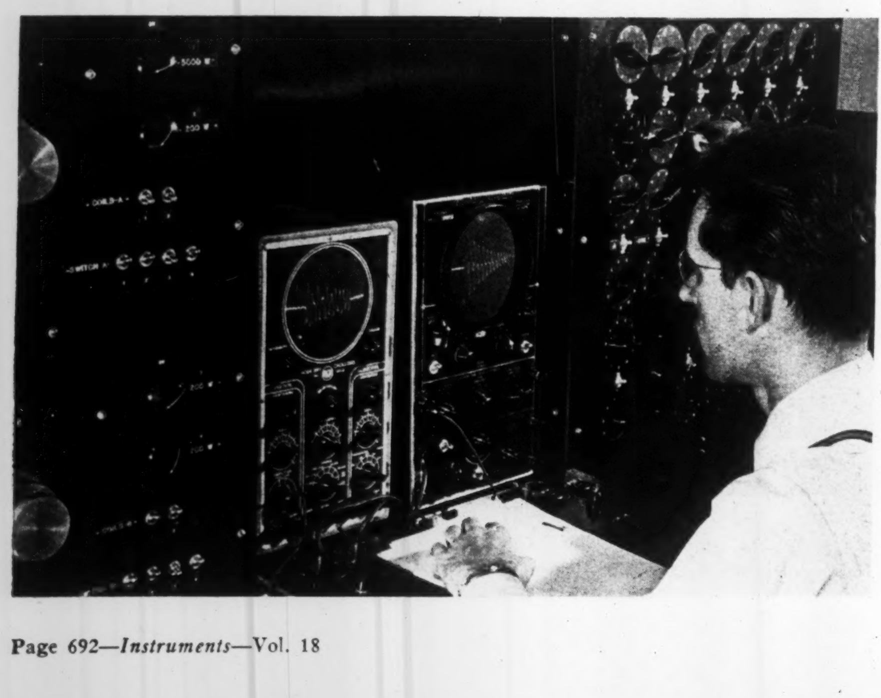
Dr. McCann reported that one problem—what would happen inside a crate of radar tubes if the crate were dropped suddenly to the ground—was solved by the robot in ten days, whereas it would have taken an engineer working eight hours a day a total of 1200 days to solve it. In the Mechanical Transient Analyzer, as it is called, electric circuits duplicate everything in the mechanical problem. The weight of the falling object, the velocity at which it strikes the ground, the amount of cushioning inside the object and other important factors are all given electrical counterparts.

"By connecting the electrical circuits in proper sequence," Dr. McCann explained, "and operating certain switches, the electrical robot can be made to work on almost any mechanical-motion problem that faces engineers today."

The answers are read on the fluorescent screen of a cathode-ray oscilloscope in the form of waves that show where and when mechanical vibrations are set up, how long they last and where the more severe stresses occur.

The apparatus was designed, originally, to meet new problems in the design and construction of turbo-generator units, but its application has been extended to include vibration problems in propulsion equipment for the Merchant Marine ships, and many other problems whose solution had been considered "unsolvable" by engineers.

"Engineers have long recognized a relationship between mechanical and electrical systems, but the development of apparatus to carry through these relations for a practical purpose has been a stumbling block to their full use," Dr. McCann asserted.



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Vol. , No. 10 M. F. Béhar, Editor October 1945

Daytime Cloud Height Reading and Recording

By J. PETERSON and J. P. FOULDS, Lighting Engineering Div., General Electric Co., West Lynn, Mass.

UNTIL the recent development of a new method of daytime cloud height reading known as the ceilometer system, ceiling measurement during the day was expensive and at times unpredictable. Small free balloons with a known rate of ascension were observed, but during bad weather such observations were impractical and the best data that could be obtained were only estimated. The ceilometer system* is gradually replacing the free-balloon method. It eliminates the uncertainties in daytime reading, functions in good weather or bad and is practical for day or night use. It provides more accurate and useful data at more frequent intervals than either the ordinary visual clinometer method or the method of timing the ascension of a balloon. When used with a suitable recorder it will provide continuous data.

The system was conceived by the United States Weather Bureau and the National Bureau of Standards and translated into practical serviceable instruments by the General Electric Lighting Engineering Division.

Basically, the measurement of cloud height is accomplished by measuring one angle of a right triangle, the base dimension of which is known. The cloud height above the ceilometer system is equal to the length of the base line times the tangent of this angle.

In practice, a powerful narrow-beam light projector, such as a searchlight, is pointed vertically upward. At a base-line horizontal distance of 1000 feet from the projector, a ceilometer detector is installed for the purpose of measuring the angle above the horizontal of the spot of reflected light on the cloud (see Fig. 1). The determination of a

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*For "New Instruments" Department description see *Instruments*, Dec. 1944, pages 786-787.—EDITOR.

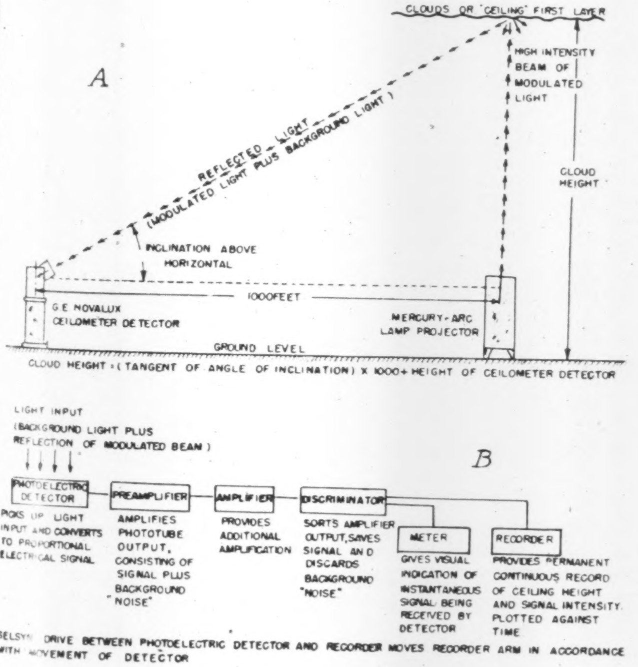
CLOUDS OR "CEILING" FIRST LAYER
A
HIGH INTENSITY BEAM OF MODULATED LIGHT
REFLECTED LIGHT
(MODULATED LIGHT PLUS BACKGROUND LIGHT)
CLOUD HEIGHT
INCLINATION ABOVE HORIZONTAL
1000FEET
G.E NOVALUX CEILOMETER DETECTOR
MERCURY-ARC LAMP PROJECTOR
GROUND LEVEL
CLOUD HEIGHT = (TANGENT OF ANGLE OF INCLINATION) X 1000+ HEIGHT OF CEILOMETER DETECTOR
LIGHT INPUT (BACKGROUND LIGHT PLUS REFLECTION OF MODULATED BEAM)
B
PHOTOELECTRIC DETECTOR
PICKS UP LIGHT INPUT AND CONVERTS TO PROPORTIONAL ELECTRICAL SIGNAL
PREAMPLIFIER
AMPLIFIES PHOTOTUBE OUTPUT, CONSISTING OF SIGNAL PLUS BACKGROUND "NOISE"
AMPLIFIER
PROVIDES ADDITIONAL AMPLIFICATION
DISCRIMINATOR
SORTS AMPLIFIER OUTPUT, SAVES SIGNAL AND DISCARDS BACKGROUND "NOISE"
METER
GIVES VISUAL INDICATION OF INSTANTANEOUS SIGNAL BEING RECEIVED BY DETECTOR
RECORDER
PROVIDES PERMANENT CONTINUOUS RECORD OF CEILING HEIGHT AND SIGNAL INTENSITY PLOTTED AGAINST TIME
SELSYN DRIVE BETWEEN PHOTOELECTRIC DETECTOR AND RECORDER MOVES RECORDER ARM IN ACCORDANCE WITH MOVEMENT OF DETECTOR

Fig. 1. Diagrams of Operation of Ceilometer
A—Method of Cloud Height Measurement
B—Elementary Diagram of the Ceilometer

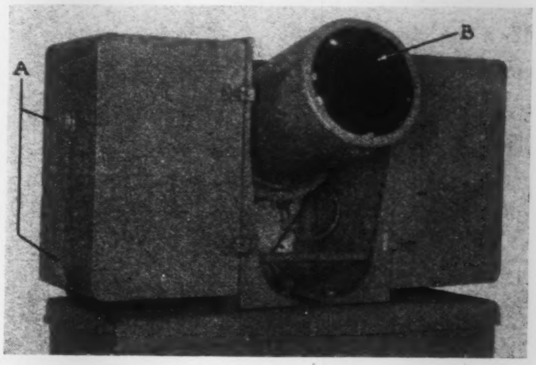

Fig. 2. Front View of Scanning Head
A—Manual elevating crank removed and opening capped
B—Lens focuses on phototube scanning head; also contains aperture baffles for extraneous light

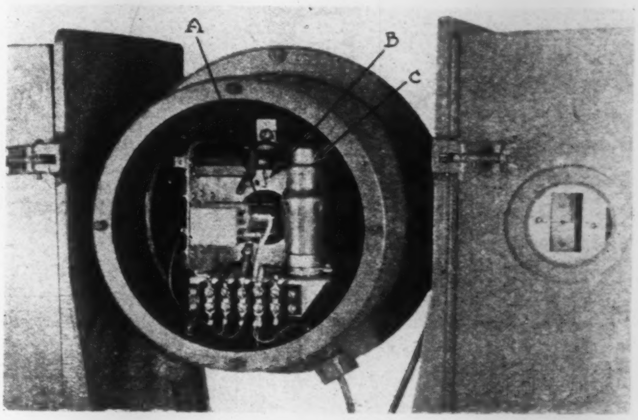

Fig. 3. Rear view of Scanning Head With Cover Removed
A—Phototube, color sensitivity matches mercury-arc spectrum
B—Aperture plate and focusing mount
C—Pre-amplifier Tube

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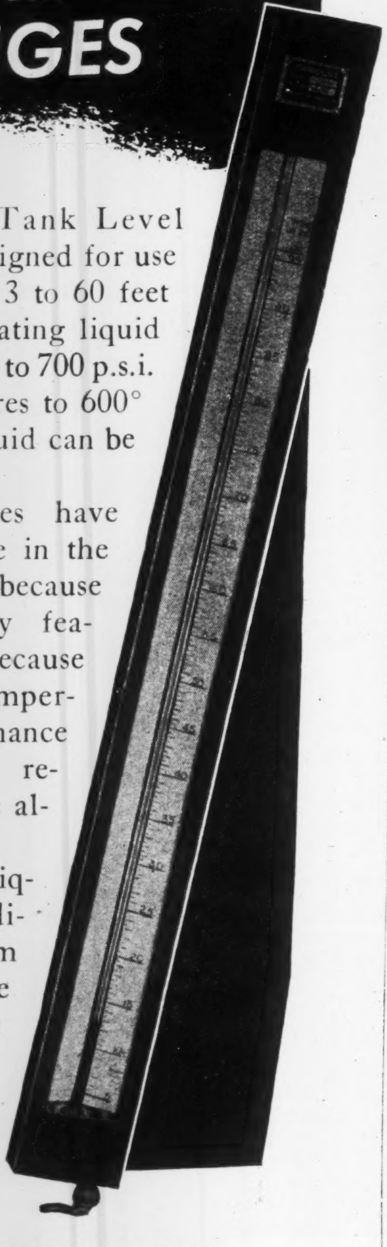

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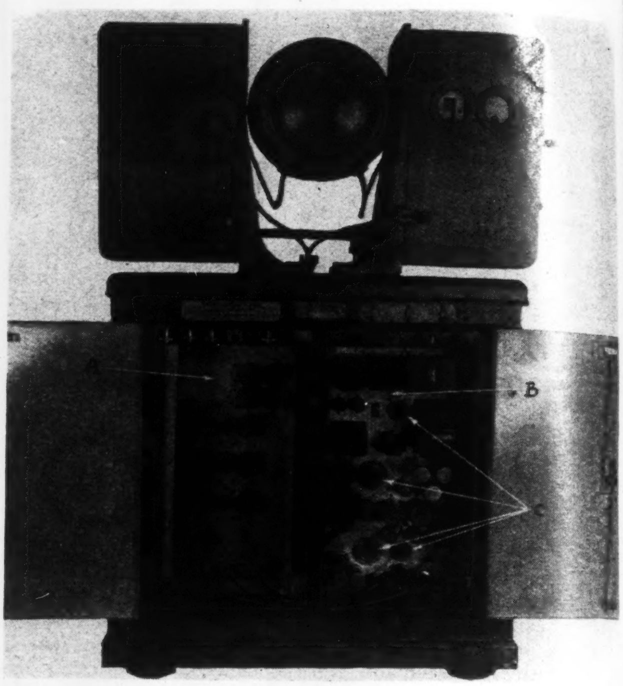

Fig. 4. Amplifier and Discriminator Panel Housing, Doors Open.
A—Amplifier panel
B—Discriminator panel
C—Adjusting knobs

cloud height thereupon becomes a simple calculation and may be reduced to a simple table.

This method has been used for years with incandescent lamp projectors and ordinary visual devices. It is simple, accurate, direct and convenient—but limited in use to hours of darkness.

The new ceilometer detector is an automatic photoelectric device of high sensitivity. It provides means for measurements under any conditions in which a light beam can be projected to a cloud or haze layer, or through successive haze layers. It employs a phototube pick-up and an electronic circuit that can discriminate between the cloud reflection of the light beam and all natural illumination including the most brilliant sunlight. This discriminator action makes daytime operation possible.

The main innovation of this method is the use of a light beam which is modulated so that it can be distinguished from daylight. This beam has as its source an air-cooled 900-watt high-intensity mercury-arc lamp about the size and shape of a cigarette. (See Fig. 7.)

The characteristics of the mercury arc lamp are such that when operated normally from 60-cycle a-c. power supply, its light automatically "flickers" or modulates at the fixed rate of 120 times per second. The human eye is not ordinarily conscious of this flickering or modulation, but a photoelectric tube will respond fast enough to "see" it. The "electric eye," therefore, is the element around which the ceilometer detector is designed.

Natural light is steady or unmodulated in contrast to the modulated character of the mercury arc light, but the photocell picks up both. Hence, the associated apparatus is designed to sort out and discard all electrical effects of any natural light and to produce electric currents proportional to the modulated light only. It is able to do this even though the extraneous light is a million times the intensity of the modulated reflected light, as in the case of bright sunlight.

Visual sighting is out of the question by day, therefore it is necessary to provide means for scanning the mercury-arc projector beam. The photoelectric pick-up looks up and down the beam, registering the point of cloud reflection automatically on a recorder located in the weather station. The scanning head, which includes the pick-up, raises and

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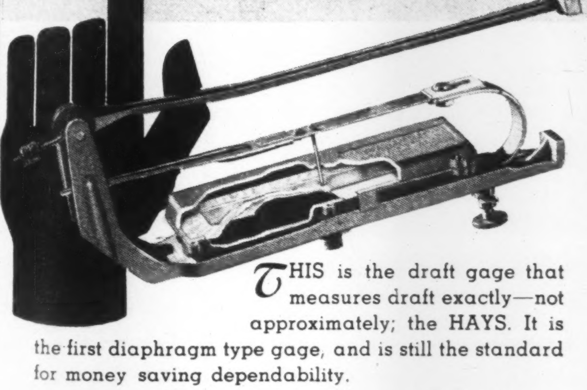

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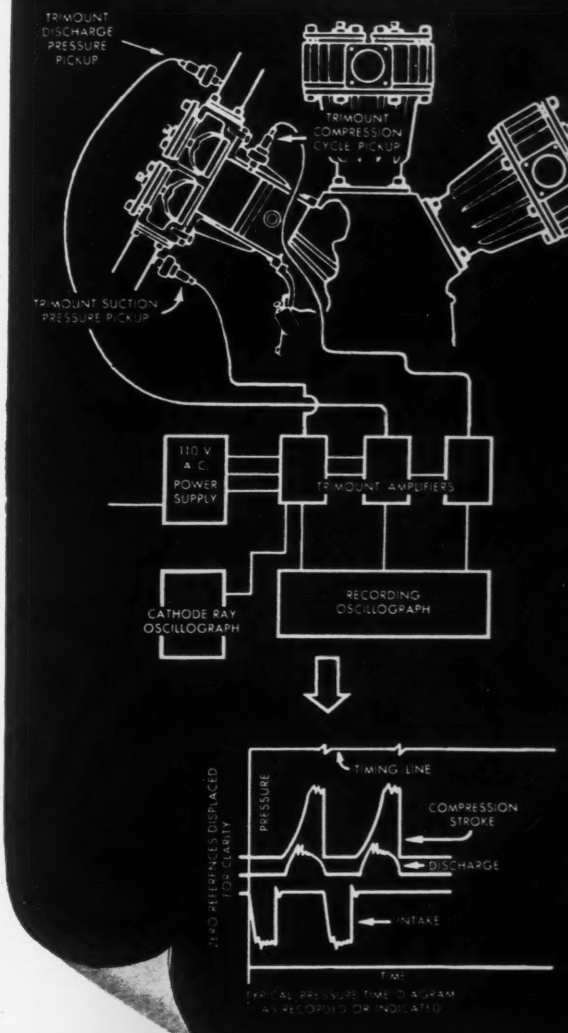
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Model 1242 (illustrated) holds two Indicators by spring-loaded fingers; an alternate type of carriage mounts Indicators to a panel by means of thumbscrews. Extra carriages to hold four or six Indicators can be furnished.

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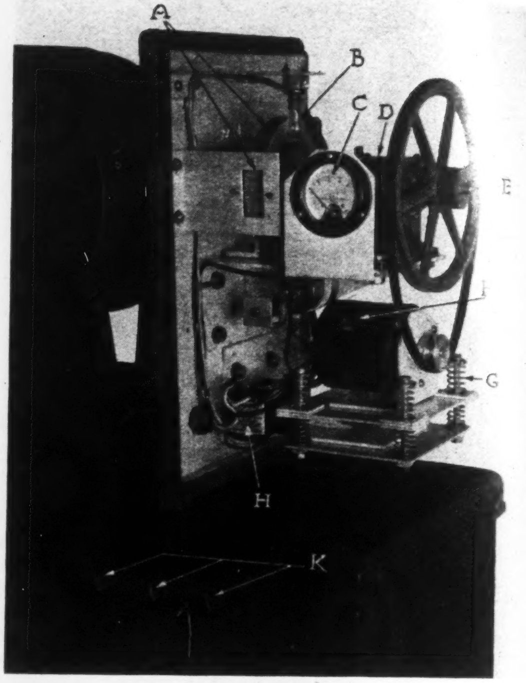

Fig. 5. Scanning Head Driving Motor Compartment, Cover Removed

A—Scale shows angle of inclination
B—Lamp illuminates dials for night operation
C—Intensity meter indicates when reflection is picked up.
D—Reduction gear provides 12-minute scanning cycle
E—Manual elevating crank attaches here
F—75 r.p.m. synchronous driving motor
G—Spring suspension prevents vibration
H—Reversing relay for motor
K—Control switches

lowers continuously in twelve-minute cycles. In the absence of a recorder, the head can be operated manually being raised and lowered until the greatest deflection o an output meter is observed. The angle of inclination a this point may be read off a scale attached to the head.

The recorder makes it possible to observe readings in

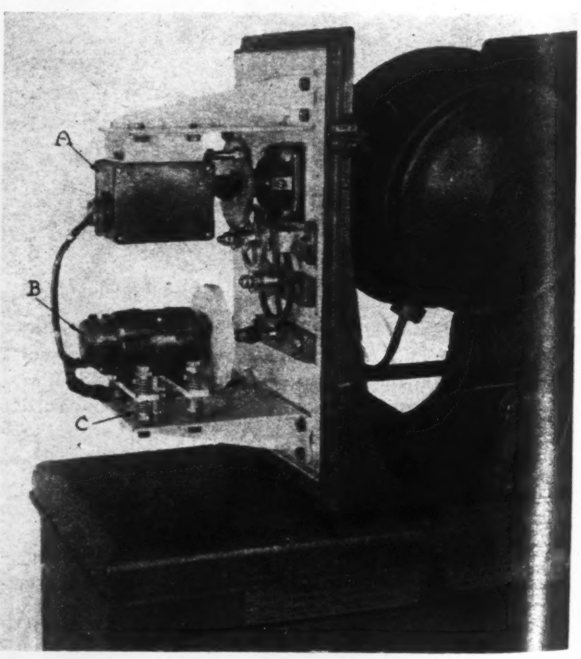

Fig. 6. Selsyn Position Transmitter Compartment, Cover Removed
A—Reversing switch for driving motor
B—Selsyn transmitter for indicating angle remotely
C—Spring mounting prevents vibration

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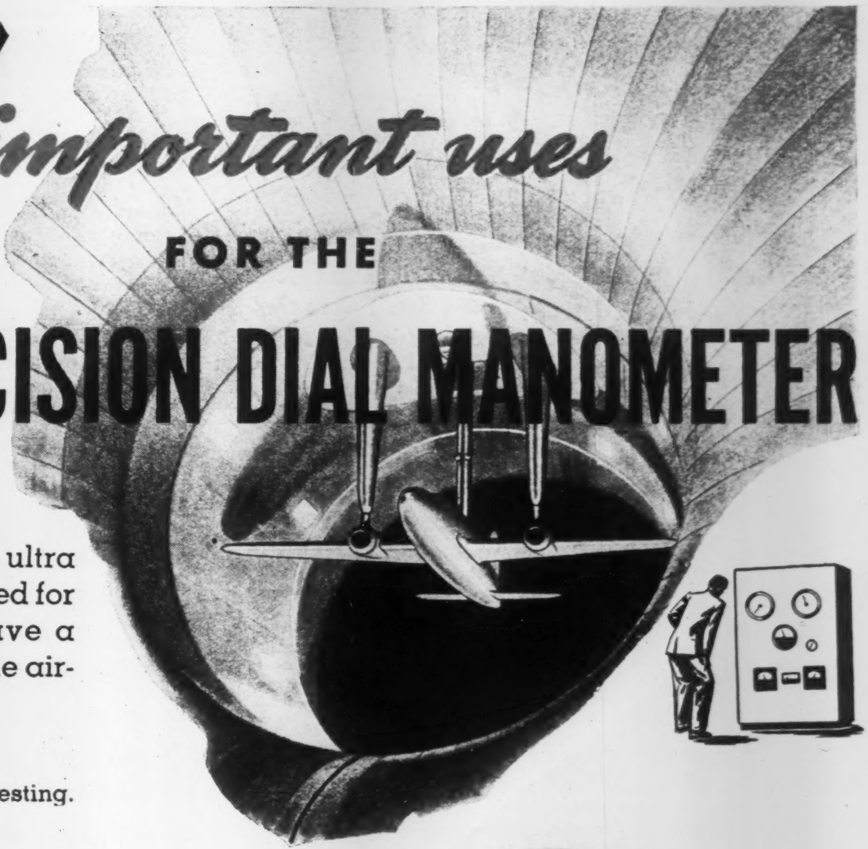

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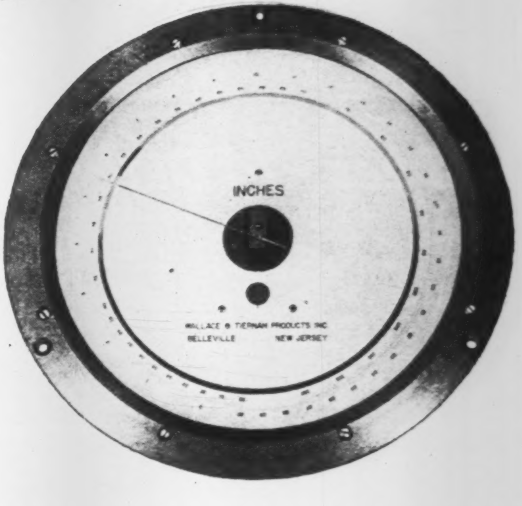

SPECIFICATIONS

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Scale Expansion: FA-145 5 times at lower range
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Scale Length: 45 inches
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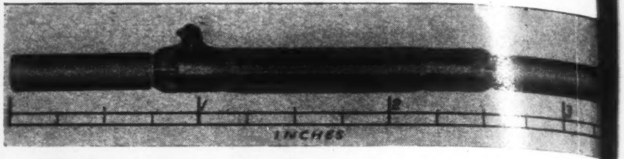


Fig. 7. High-Pressure Mercury-Arc Lamp Air Cooled, Type BH-6

doors and, in addition, provides a permanent record o cloud variations. The unit consists of a duplex char recorder and amplifier, rectifier, electronic relay and control panel mounted in a cabinet for table-top operation.

The angle of inclination of the photoelectric detector i recorded by a Selsyn-driven, inkless, rapid-dotting mechanism on the left-hand side of the chart. At the same time the signal output of the ceilometer is recorded by a milliammeter element and an ink mechanism on the right han side of the chart (see Fig. 10).

The angle-recording inkless dotting device records onl when the signal exceeds a threshold value slightly below th minimum signal necessary to indicate the presence of cloud ceiling, although the recording mechanism is move continuously in coördination with the photoelectric detecto even when a signal is not being received.

Since the angle element records only when a signal i being received, the periods of angle recording are of relatively short duration and, therefore, appear on the char as widely separated short dashes. The middle of the das is easily estimated and the corresponding angle read o the printed scale on the chart paper.

The angle recording element, however, does not yield an information as to the density of the clouds. An indicatio of the character of the cloud formation can be obtaine from the signal record since this element records continuously regardless of whether or not the angle indicatin

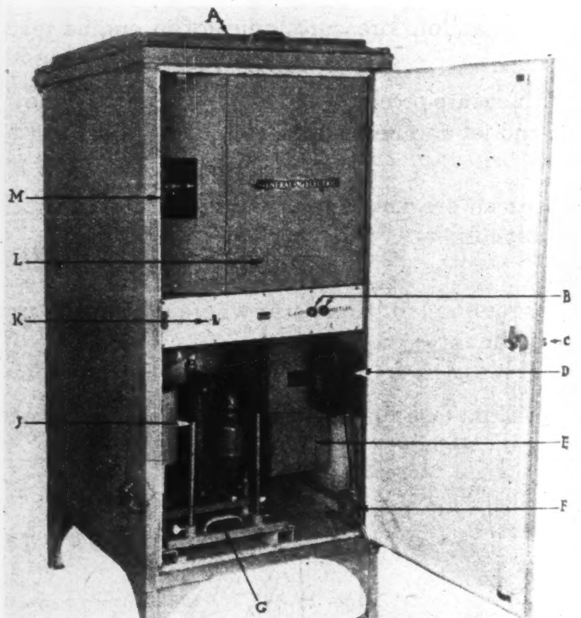
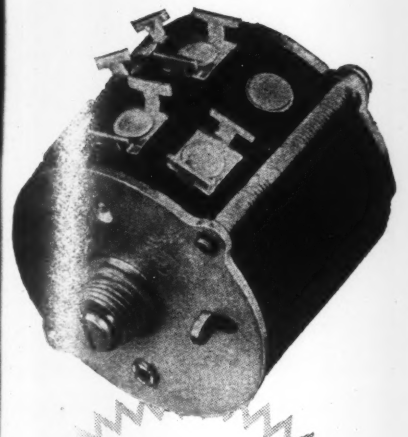


Fig. 8.

A—24″ projector with flat heat and impact-resisting glass
B—Fuses
C—Lock
D—Autotransformer compensates for line voltage drop
E—Ballast transformer for mercury-arc lamp
F—Junction box for power supply connection
G—Sliding shelf for air compressor
H—Motor-driven air compressor
K—Off-on switch
L—Safety door with interlock switch
M—Lamp focusing mechanism



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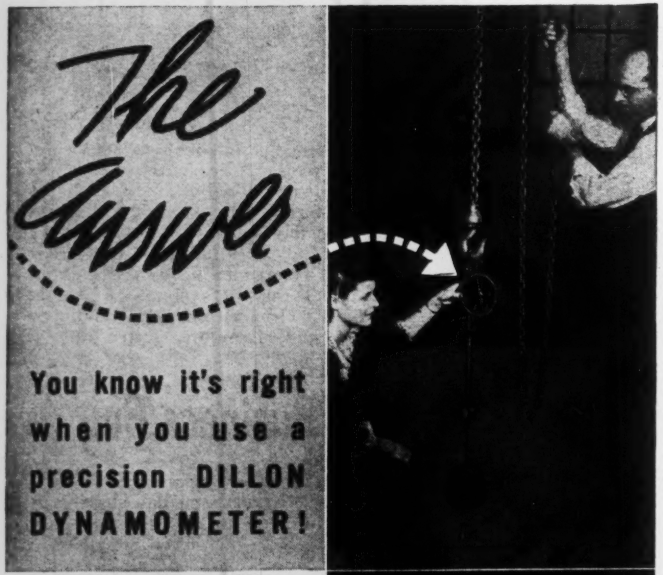

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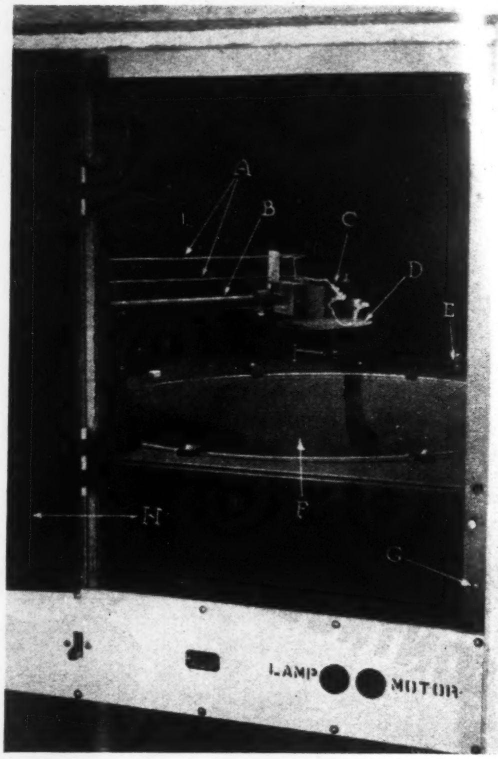

Fig. 9. Lamp Nozzle Assembly, Sun-shield and Main Reflector
A—Electrical connections to lamp mounting
B—Lamp support and air connection
C—900-watt type HB-6 mercury-arc lamp
D—Sun shield, prevents heat concentration on lamp when projector is shut off
E—Automatic retractor solenoid for sun shield
F—Precision grade search-light mirror, 24" dia.
G—Door switch operating pin
H—Safety door prevents exposure to electric shock and ultraviolet radiation

element is recording. The magnitude of the valleys and peaks in the signal chart contributes considerable information to the meteorologist as to the nature of the cloud formation.

The record is plotted against time, a complete cycle

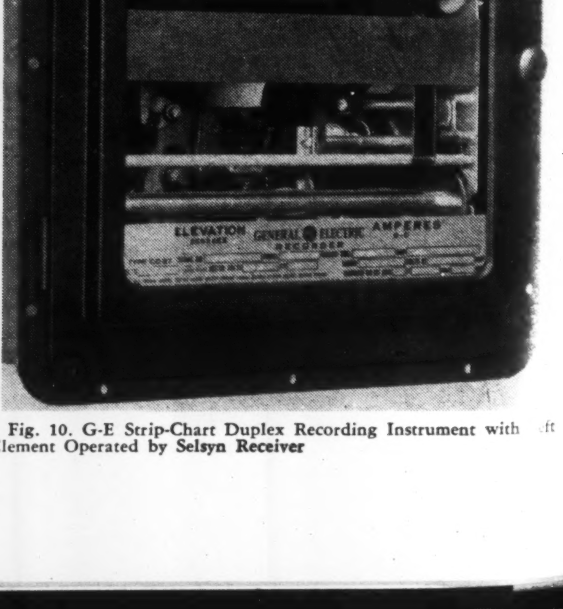

Fig. 10. G-E Strip-Chart Duplex Recording Instrument with ft Element Operated by **Selsyn Receiver**

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An out-of-balance vibration of .0000002 (two-tenths of one-millionth) inch in the balancing of *small* high-speed rotating parts is next to infinitesimal . . . so small that the human mind can scarcely comprehend it.

Yet if we were to pencil a perfectly balanced small rotor, the weight of the mark would cause an out-of-balance vibration of this magnitude.

Sperry's new Universal Dynamic Balancing Machine, the *Strobodyne*, makes *detection* and *correction* of this infinitesimal displacement possible. In small rotors where the speed range is from 3000 to 100,000 r.p.m., small unbalance is often serious. Dynamic loads arising from any unbalance result in rapid deterioration of the bearings.

The *Strobodyne* not only increases bearing life by reducing bearing load, it also has the uncanny ability to distinguish between small vibration due to unbalance and vibration caused by bearings and pivots.

The *Strobodyne* is simple and safe to operate. A meter gives the operator an accurate and *direct* indication of the *amount* of material to be removed from the rotor in terms of drill depth. From dial readings on the balancing machine, the exact *location* of unbalance is obtained. This information is simply transferred to the drilling machine for correction of the out-of-balance condition.

The balancing machine is adaptable for rotors up to 5" diameter and 8" length. Adaptors for all types of rotors and high-speed motor armatures are available or may be designed to meet customer's requirements. Less than two minutes are required to change the machine setup from one type of rotor to another.

The *Strobodyne* is but one of the specialized precision tools which Sperry has developed and has available for the production, maintenance, and repair of precision instruments. Write to our Aeronautical Department for further information.

*Trade-Mark

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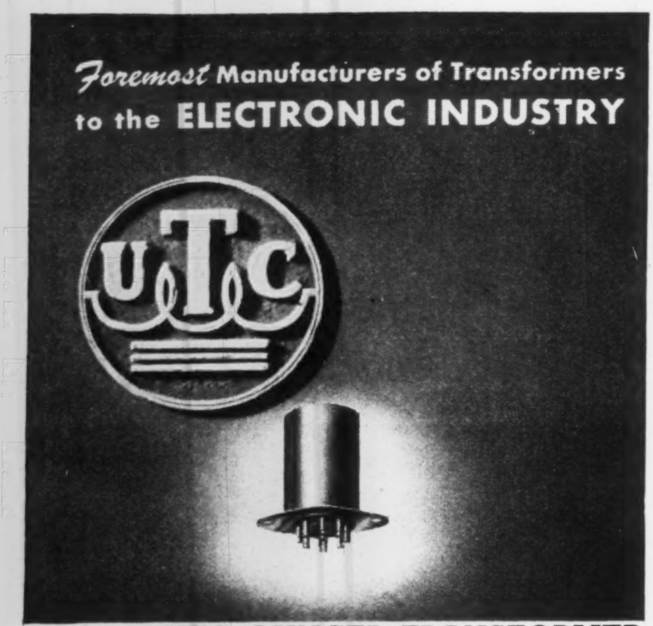
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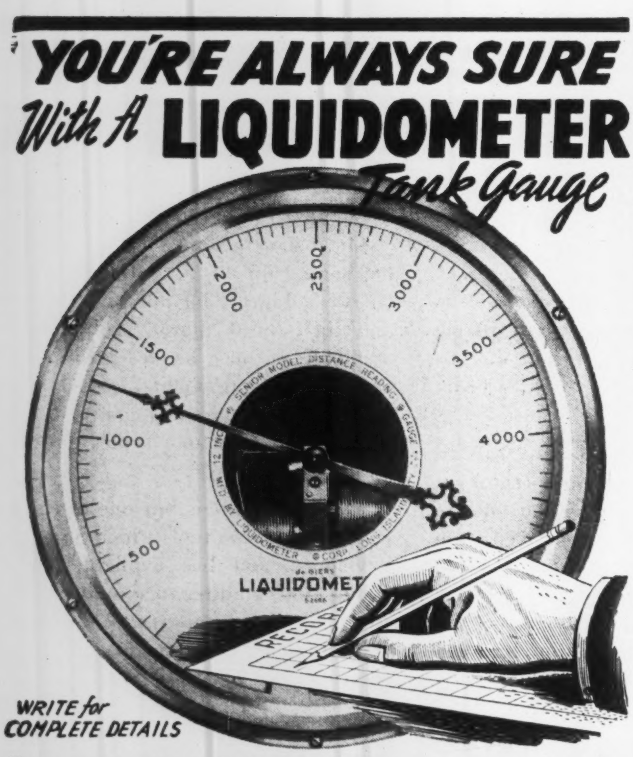
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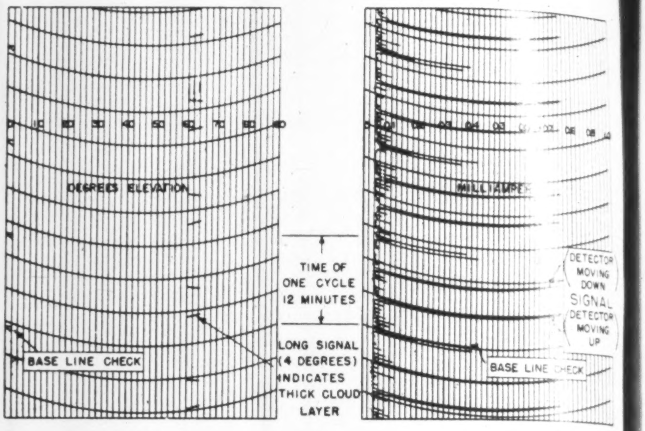
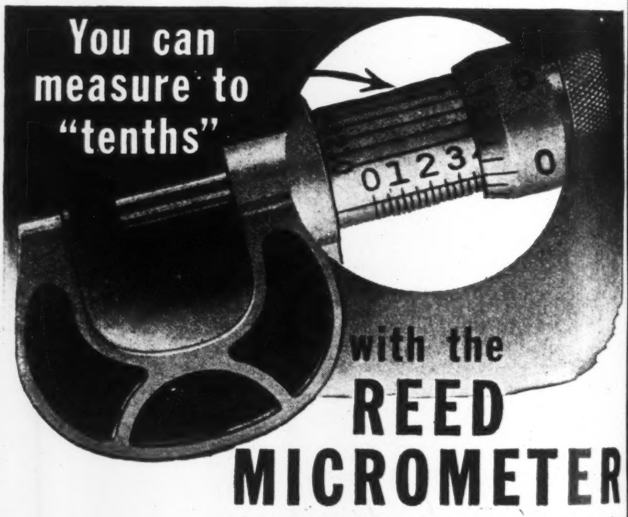


Fig. 11. Portion of Typical Chart and Explanation of Autographic Markings

requiring twelve minutes. A base line signal serves as a check of the operation of the projector, ceilometer, and recorder, its presence indicating that all parts of the equipment are functioning correctly. If a base line check were not provided, it would be impossible to tell whether a chart showing no cloud ceiling was actually due to an absence of clouds or to faulty operation of the equipment. Both the projector and the ceilometer are built for outdoor installation at weather stations, notably those serving the needs of air traffic.

With the ceilometer method it has been found easily possible to measure cloud heights up to 20,000 feet in full daylight. With its perfection, new possibilities of weather measurement are predicted for future weather reporting and forecasting.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"Tenths" are here to stay—and here is the micrometer to measure them. Vernier (as shown above) gives easy reading to 1/10,000". Micrometer screw burnished for added hardness and long maintained accuracy—also smooth action of spindle for sensitive and uniform measuring. Strong, rigid frame, beautiful finish—a real Scherr precision tool, part of a line which has helped largely to make modern precision measuring and inspection common practice in a thousand shops.

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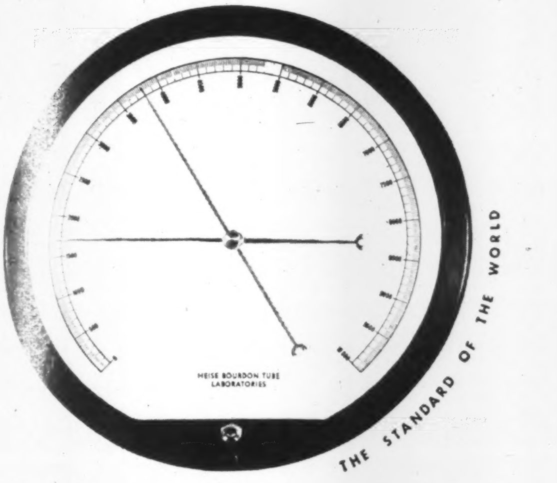

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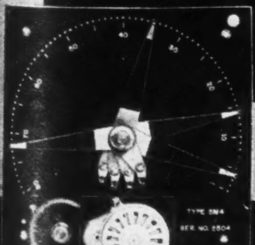

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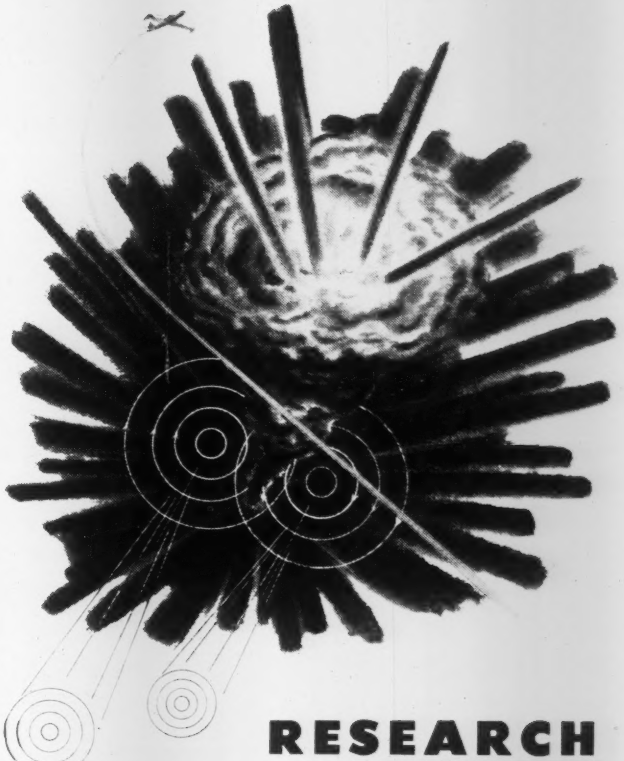

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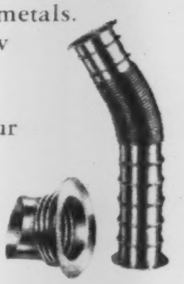

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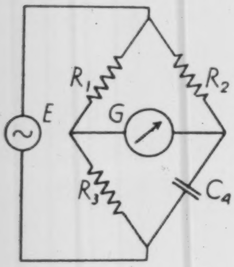
MAYWOOD, ILLINOIS

Plants: Maywood and Elgin, Ill.

ELECTRIC GAGING METHODS

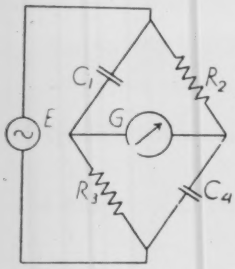
Continued from page 689

which are available, although in a general sense they are recording oscillographs. They are, however, almost always single-channel instruments (excepting the multi-point potentiometer recorders) and their upper limit of frequency response is at the most only a few cycles per second, so that they are actually in practice devices for recording varying magnitudes rather than the wave-forms of the more rapid phenomena ordinarily termed transients. Within their special field of application, they are often capable of greater accuracy than the oscillographs.



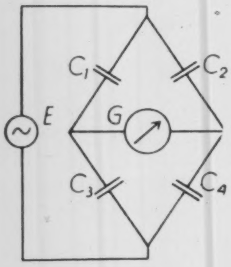
$$\frac{R_1}{R_2} = \frac{R_3}{-j/\omega C_4} \; ; \; C_4 = \frac{-j\,R_1}{\omega R_2 R_3}$$

FIG. 138



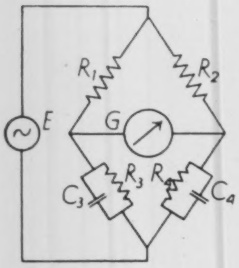
$$\frac{-j/\omega C_1}{R_2} = \frac{R_3}{-j/\omega C_4} \; ; \; C_4 = \frac{-1}{\omega^2 R_2 R_3 C_1}$$

FIG. 139



$$\frac{-j/\omega C_1}{-j/\omega C_2} = \frac{-j/\omega C_3}{-j/\omega C_4} \; ; \; C_4 = \frac{C_2 C_3}{C_1}$$

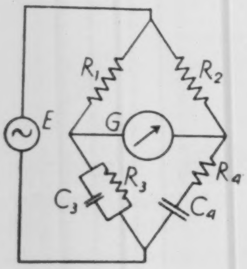
FIG. 141



$$\frac{R_1}{R_2} = \frac{1/(1/R_3 + j\omega C_3)}{1/(1/R_4 + j\omega C_4)}$$

$$\frac{C_4}{C_3} = \frac{R_1}{R_2} = \frac{R_3}{R_4}$$

FIG. 143

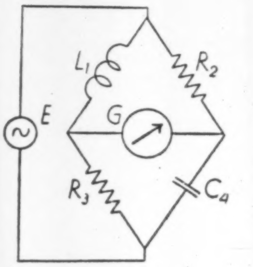


$$\frac{R_1}{R_2} = \frac{1/R_3 + j\omega C_3}{R_4 + 1/j\omega C_4}$$

$$\frac{C_3}{C_4} = \frac{R_2}{R_1} - \frac{R_4}{R_3}$$

$$C_3 C_4 = 1/\omega^2 R_3 R_4$$

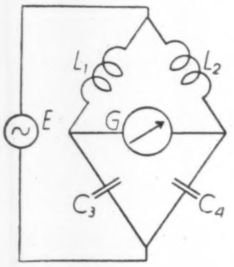
FIG. 144



$$\frac{j\omega L_1}{R_2} = \frac{R_3}{-j/\omega C_4}$$

$$C_4 = \frac{L_1}{R_2 R_3}$$

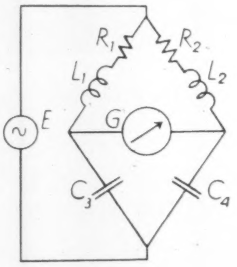
FIG. 146



$$\frac{j\omega L_1}{j\omega L_2} = \frac{-j/\omega C_3}{-j/\omega C_4}$$

$$\frac{C_3}{C_4} = \frac{L_2}{L_1}$$

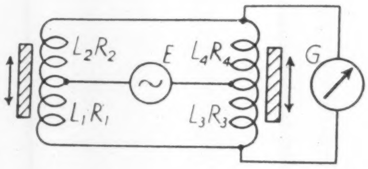
FIG. 147 A



$$\frac{R_1 + j\omega L_1}{R_2 + j\omega L_2} = \frac{-j/\omega C_3}{-j/\omega C_4}$$

$$\frac{C_3}{C_4} = \frac{L_2}{L_1} = \frac{R_2}{R_1}$$

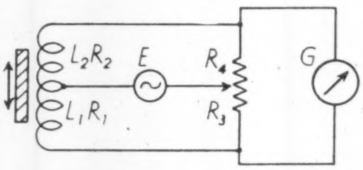
FIG. 147 B



$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \; ; \; \frac{L_1}{L_2} = \frac{L_3}{L_4}$$

$$\frac{R_1}{R_2} \cong \frac{L_1}{L_2}$$

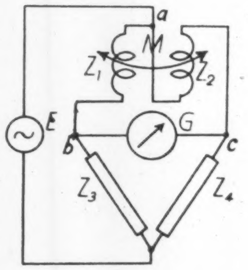
FIG. 151 B



$$\frac{R_1 + j\omega L_1}{R_2 + j\omega L_2} = \frac{R_3}{R_4}$$

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} = \frac{L_1}{L_2}$$

FIG. 152



$$Z_1 = R_1 + j\omega L_1$$

$$Z_2 = R_2 + j\omega L_2$$

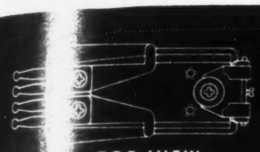
$$\frac{R_1 + j\omega(L_1 + M)}{R_2 + j\omega(L_2 + M)} = \frac{Z_3}{Z_4}$$

FIG. 154

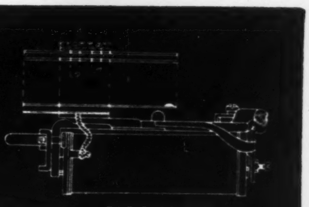
NOTICE OF ERRATA

Instruments this month reprints a number of the igures and equations published in the May and June (1945) nstallments of this serial. In each of these some change s been made from the form in which it previously appear

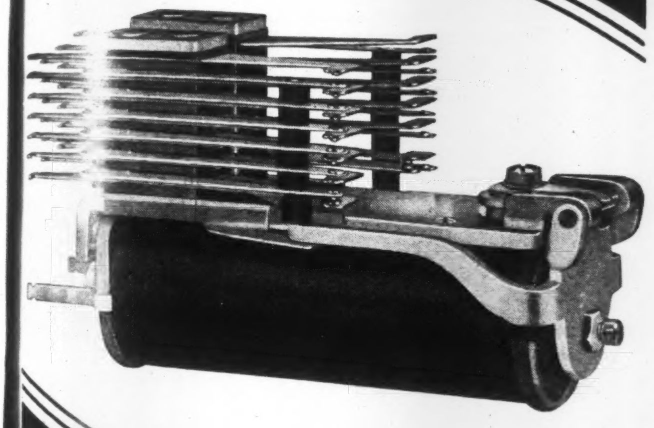
Some of these changes are corrections of actua nathematical errors—these, fortunately, are few. Some e corrections of "typographical errors"—omission of si s, mis-

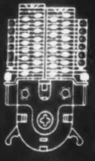


TOP VIEW



SIDE VIEW





END VIEW

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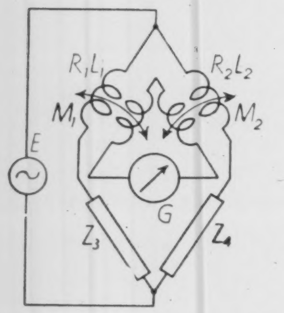
placement of subscripts, etc.—which confuse the reader only momentarily. And some are merely rearrangements of the material to avoid possible ambiguity if the figures and text are separated.

There has been a flattering and encouraging response to the publication of these added chapters describing bridge and potentiometer circuits; it is especially flattering that many readers have set them aside as a miniature textbook of bridge and potentiometer practice. It must be emphasized, however, that (as stated in the text) not all of the standard circuits are described, and that those which are included are discussed only within the limits of their application in gaging practice. It is an indication of the interest with which these installments have been received that readers have spotted "errors" in some of the standard "textbook" circuits and equations as applied to the special conditions outlined in the text.

So many readers have expressed interest in these chapters that both *Instruments* and the author wish to make them as nearly as possible free from both errors and ambiguities. It is for this reason that some changes other than correction of errors are made.

The author wishes to express his gratitude to all those readers who have offered comments, and in particular to Messrs. C. G. Ball of Chrysler Corporation, J. L. C. Löf of M.I.T., W. L. Schwalbe of the University of Illinois, and W. H. Thurston of Shell Development Company, for suggestions as to content and manner of presentation, and for pointing out some of the errors which are here corrected.

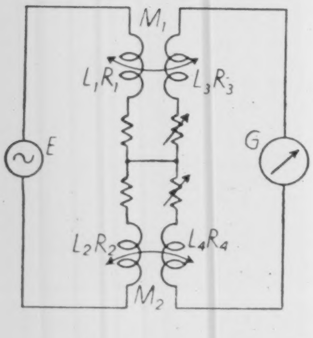
HOWARD C. ROBERTS



$$\frac{L_1}{L_2} = \frac{R_1}{R_2} = \frac{R_3}{R_4}$$

$$\frac{M_1}{M_2} = \frac{Z_3}{Z_4}$$

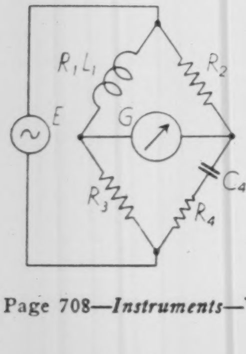
FIG. 158



$$\frac{L_1}{L_2} = \frac{L_3}{L_4} = \frac{R_1}{R_2} = \frac{R_3}{R_4}$$

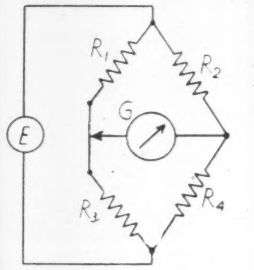
$$M_1 = M_2$$

FIG. 159



$$L_1 = R_1/\omega^2 R_4 C_4$$

FIG. 162



$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

FIG. 163

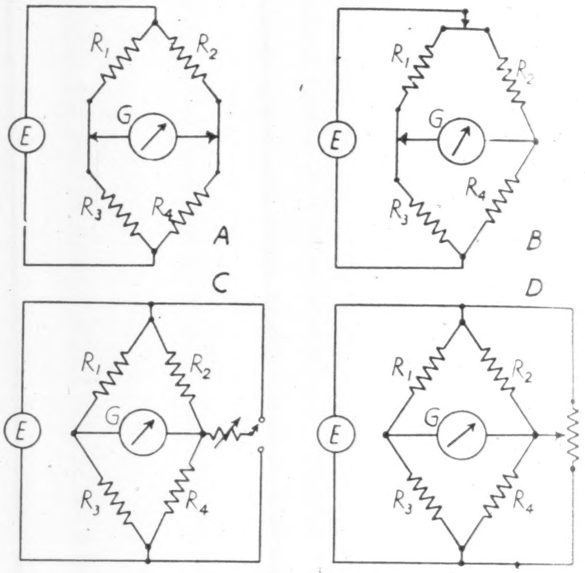
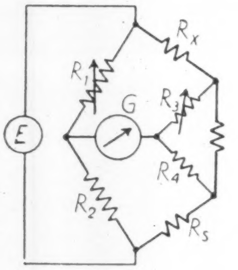
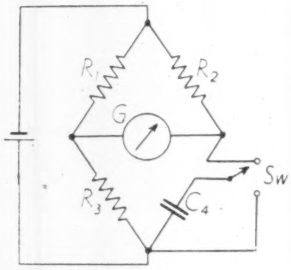


FIG. 164



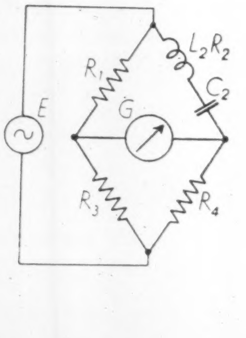
$$\frac{R_1}{R_2} = \frac{R_x}{R_s} = \frac{R_3}{R_4}$$

FIG. 165



$$N \doteqdot R_1/R_2 R_3 C_4$$

FIG. 167



$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

$$\omega L_2 = 1/\omega C_2$$

$$f = 1/2\pi\sqrt{L_2 C_2}$$

FIG. 168

NOS. 0000, 000, 00 AND 0

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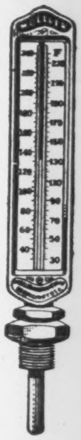

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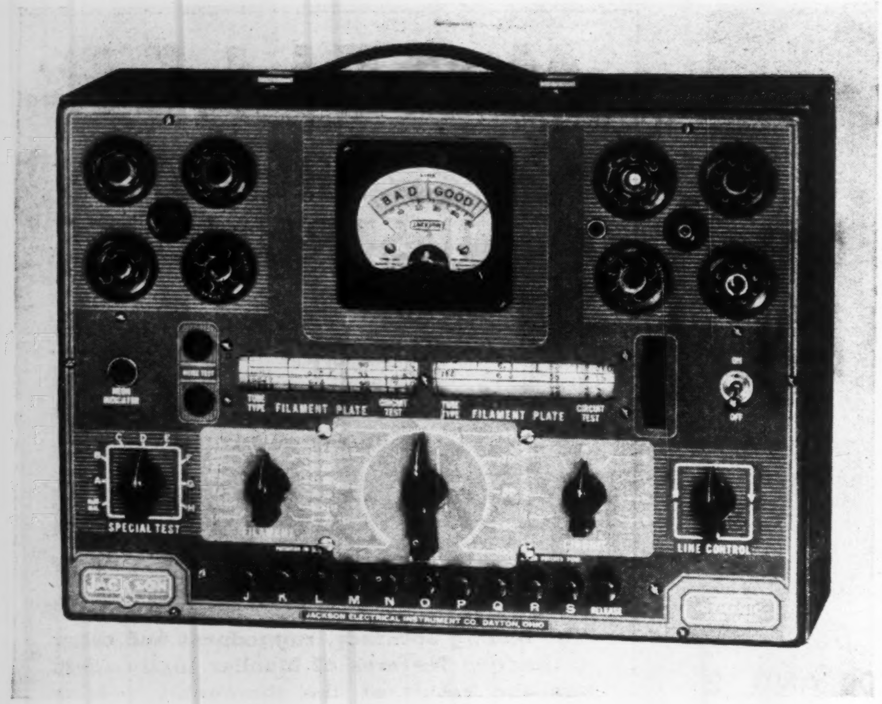

Model 636 Dynamic* Tube Tester

With Built In Rotary Tube Chart

Tops in design and performance including the latest Jackson patented switching circuits.

Modern in every feature of construction, appearance and operation.

Complete with every valuable feature. Up to date for all newest tube types.

SPECIFICATIONS

"Dynamic" Method of Test—Makes a better test on every tube. The "Dynamic" method is more accurate, frequently finding "poor" tubes which might pass for "good" in ordinary testers.

Tests All Tubes—All of the popular receiving types and television amplifiers, including *Bamtams—Loctals—Single Ended—High Voltage Filament Types and Miniatures.* Provision for many more. The tester is protected against obsolescence in every possible feature.

Roll Chart tube index—simplifies correct settings.

Full Range Filament Selection—marked directly in volts.

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Bench Model 636-B (illustrated) is installed in welded steel cabinet. This instrument is also furnished (portable model 636) in a French grey leatherette case with removable lid—matched in dimensions and finish to other testing instruments in the Jackson line. It can be assembled with them in the Jackson Service Lab. Buy now with an eye ahead—on a *matched* Jackson testing set.

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Recorder Inks and Papers

To the Editor of *Instruments*:

Recent increase in the use of recording instruments, with an accompanying increase in the number of copies that must be made of the recordings, has given rise to a reproduction problem which is rapidly becoming acute.

With a few exceptions, recording instruments are designed to use special inks and special papers, obtainable only from the manufacturer of the instrument. Most of the inks are not only not black, but of such anaemic or bilious hues that they are difficult to photograph as a full tone with any standard film and filter combination.

Recorder charts are likewise poorly colored, with the graduations in many instances (poorly) printed in "seasick" green or "mud" brown, so that they cannot be photographed as a full tone with standard film and filter combinations. In too many instances, the chart lines not only cannot be copied as a full tone by standard methods, but they cannot be "dropped out" either.

It is felt that the time is appropriate for a standardization conference on the subject of recorder inks and papers, so that color combinations and tones are such as to permit "clean" copies of the records by any ordinarily competent commercial photographer.

Charts should also be plainly marked with the film and filter combinations necessary to produce standard desired effects. For example:

Chart #310 (blue lines)
Use #211 ink (black)

To copy both record *and* chart lines as full tones, use Kodalith Pan film and Wratten A filter.

To copy record as full tone and chart lines as halftone, use Kodalith Pan film and no filter.

To copy record as full tone and drop out chart lines, use Kodalith Pan film and Wratten B filter.

A definite effort should be made to standardize the colors used by a manufacturer, so that one batch of paper and ink is at least similar in color to another batch.

RONALD L. IVES
Dugway Proving Ground
Tooele, Utah

August 11, 1945.

METAL-SORTING METHOD

Continued from page 681

when reciprocated against one another. On the other hand, when a bar of ingot iron was reciprocated against each in turn, a deflection of 560 microvolts was obtained with one while the other showed a deflection of 800 microvolts. The difference of 240 microvolts against the ingot iron standard is not in line with the expectancy according to the thermodynamic laws governing thermoelectric effects.

In general, however, all metals and alloys may be arranged in triboelectric series form such that a metal which precedes another metal in the list or table will always be found to be positive with respect to the succeeding metal. In a triboelectric series of five

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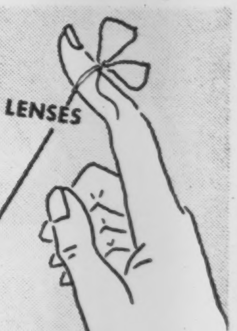

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Exceptionally high torque to weight ratio of control springs to moving element insures minimum error under conditions of shock, vibration, and other rough usage.

Alignment of jewels and magnet core piece is such that the center lines of these parts coincide within plus or minus .002". The design of the brass movement frame and components is such that mechanical tolerances are reduced to a minimum in assembly. As a result, jewel and pivot wear is uniform which reduces "frictional torque" of the moving coil.

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metals A, B, C, D and E, for example, C will be found positive to D and E but negative to A and B. Furthermore, C will be less positive (by a smaller reading) to D than to E and, correspondingly, less negative to B than to A. A table of this kind, covering the alloys of principal interest, can be of great assistance in rapid sorting.

Observation of the triboelectric effect by means of oscillographic methods discloses that the current generated by friction between two dissimilar metals, and which to the microvoltmeter appears as a steady value of direct current after saturation is reached, is actually composed of a series of unidirectional pulses of the frequency order of 1 kilocycle per second. The frequency of these pulses seems to be somewhat relative to the physical condition of the contacting surfaces as well as the grain size of the steels and further investigatory work along these lines is being carried on at the present time. Under these conditions it appears that the peak emf. is generated immediately that friction between the metals is achieved and is not dependent upon the nature of the motion causing the friction. That is to say, a rotary motion or a reciprocating motion, regardless of its speed above a certain minimum, produces the maximum peak emf's which it is possible to produce. But the peak values are governed by the metallurgy of the specimens and are not affected by the physical conditions of the surfaces of the specimens. The results of these experiments rule out conclusively any relation between the triboelectric and the thermoelectric effects.

The triboelectric method of sorting metals has been embodied in a new instrument named "Metalsorter."

[EDITOR'S NOTE.—For a description of this practical embodiment see the New Instruments Department report on pages 662-663 of our September issue.]

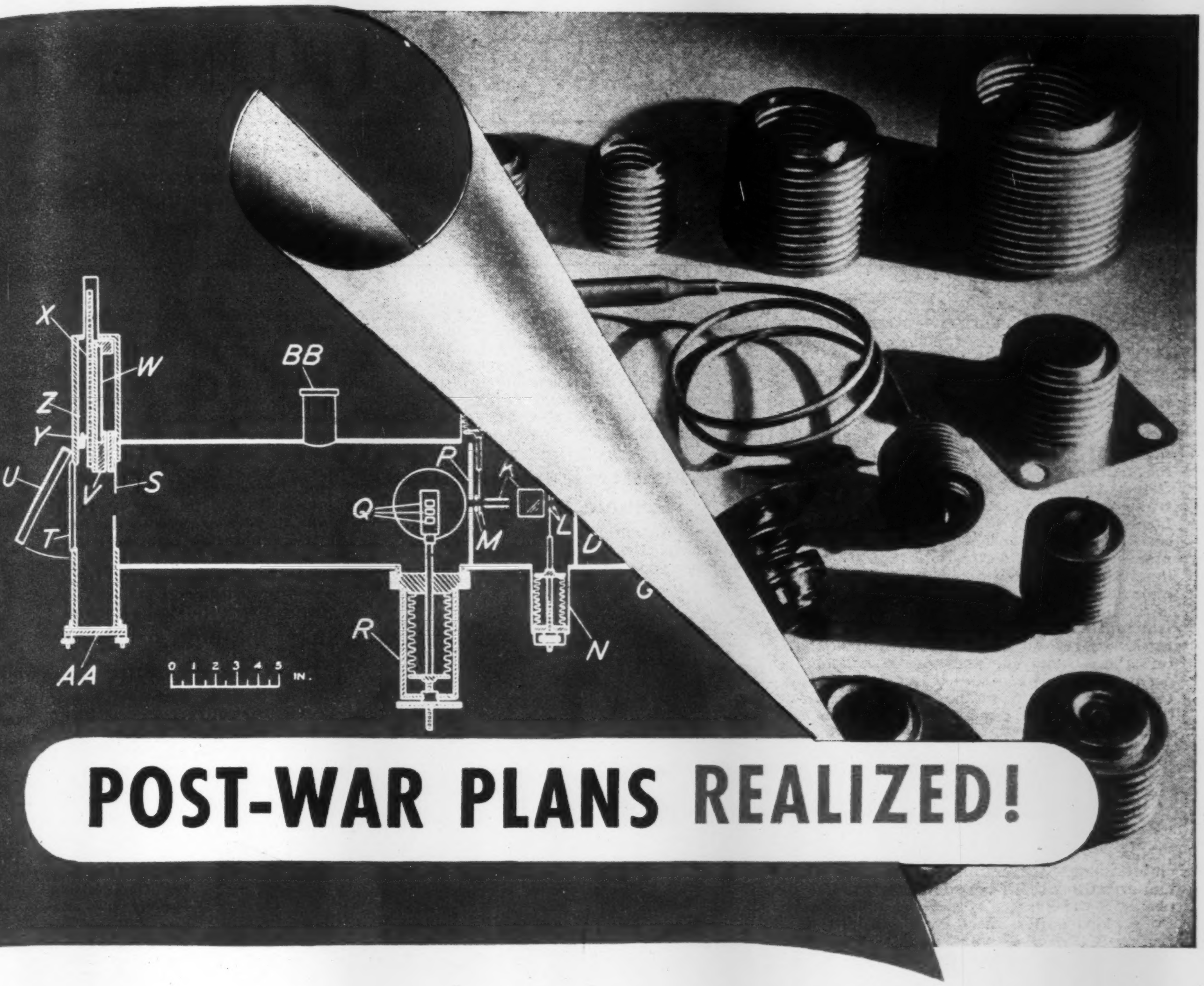
SPECIAL TESTERS

Continued from page 679

quantity of bearings can be cleaned before the solvent is unfit for use. Varsol is commonly used as the solvent.

Over-oiling of a bearing will increase its total frictional torque under test. The reason is that, in addition to the Coulomb friction, the presence of the oil creates a viscous drag which gets larger as the rotational speed increases. For gimbal bearings a drop of oil from the end of a small wire or an eye dropper with a fine point (shown in vial cap) will suffice. The function of the oil is more to prevent the bearing surfaces from rusting than to decrease the frictional torque.

The tester is supplied with nine adapters to fit all sizes of inch-type instrument bearings from ⅝" o.d. by ¼" bore to ⅛" o.d. by 1/32" bore. If found necessary, a new weight can be used to decrease the radial load on the miniature ball bearings.



POST-WAR PLANS REALIZED!

SUCCESS IN ADVANCE . . . right now the future of many post-war products is being assured *well in advance* . . . For today more and more manufacturers are saying: *"Let's get in touch with Bridgeport Thermostat; let's incorporate Bridgeport bellows assemblies in our new designs."*

What is the result?

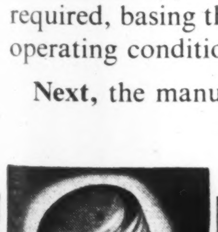
First, Bridgeport Thermostat engineers study Mr. Manufacturer's proposed product . . . specify the size and type of bellows and bellows assembly required, basing their recommendations on exact operating conditions.

Next, the manufacturer, acting on Bridgeport Thermostat's report, either buys bellows and completes his assemblies in his own shop or has Bridgeport do the entire job. If he does the latter he receives bellows assemblies on schedule, built to exact specification . . . ready to install . . . *usually at a cost much lower than would have been possible in his own plant.*

Yes, Bridgeport technique is the secret ingredient in countless devices which will amaze the post-war world with their ingenuity and efficiency.

Write for Bulletin TE-100. It contains information of interest to everyone concerned with design and production of mechanical devices.

Bellows Assemblies . . . Bellows . . . Bellows Devices



BRIDGEPORT THERMOSTAT

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The Month's NEW INSTRUMENTS

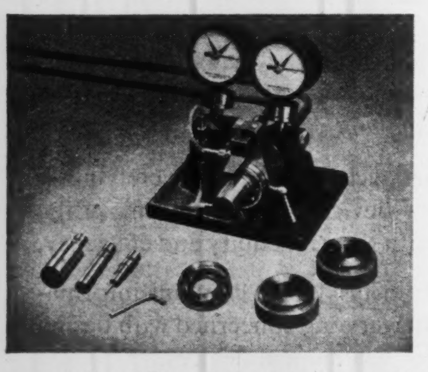
In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions. When writing to manufacturers directly, please mention this department. Or write to Information Section, Instruments Publishing Company.

Electrical Pressure Transmitter

New pressure transmitter is said to make possible for the first time the recording of pressures on any continuous-balance potentiometer, to simplify many pressure transmission problems and to make possible many studies heretofore impossible. By means of a special switching arrangement, more than one pressure can be recorded on the same instrument, which makes new transmitter particularly valuable where a large number of pressures are to be recorded simultaneously. Installation of new pressure transmitter is unusually simple, involving simple wiring instead of elaborate piping. Size and weight are small, and it is available for any type pipe fittings. This transmitter is usable for gases or liquids for pressures up to 1000 lbs./in.2. No batteries are required, and the calibration is permanent. New pressure transmitter is said to have a "wide" temperature range, and no amplification is required.—*Trimount Instrument Co., 37 W. Van Buren St., Chicago 5, Illinois.*

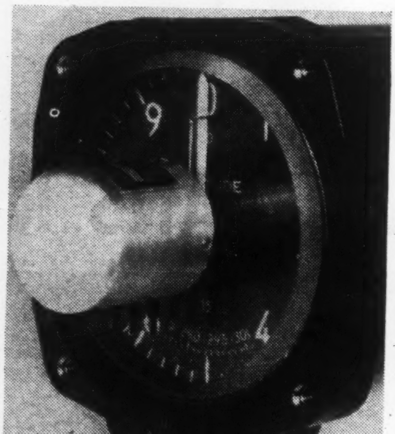
Adjustable Inside- and Outside-diameter Air Gage

New pneumatic comparator gage, for simultaneous inspection of I.D. and O.D., has an adjustable feature which permits its use on a wide range of sizes in both dimensions. Model illustrated will accommodate work with bores as small as 0.150" and outside diameters of ⅝" up to 3⅜". Photograph shows gage set up for inspection of a 35-mm. ball bearing (72 mm. O. D. race) to tolerances of 0.0003". Maximum and minimum master rings for this size bearing are in the right foreground. Interchangeable plugs for three smaller inside diameters are also shown. The adjustable jaws which measure the O.D. and the interchangeable plugs which measure the I.D. are both equipped with pneumatic gaging nozzles. These nozzles do not touch the work being gaged. A cam lock fixes the pneumatic plug in correct position and provides a leak-proof air connection. The O.D. gaging jaws are adjustable over the full range of outside diameters. Reference surfaces, for use in setting the gage, are provided on the jaws behind the gaging position. In order to locate these adjustable members, an acceptable work piece—such as bearing shown in photo—is placed at bottom of plug, and the reference surfaces are brought in contact with the work. This determines correct position of jaws with respect to the plug, and provides correct clearance for the gaging nozzles. Need for micrometer adjustment screws is eliminated. The jaws are locked with set screws, and the acceptable workpiece is allowed to remain in the setting position while the gage is in operation.—*Moore Products Co., H & Lycoming Streets, Philadelphia 24, Pa.*



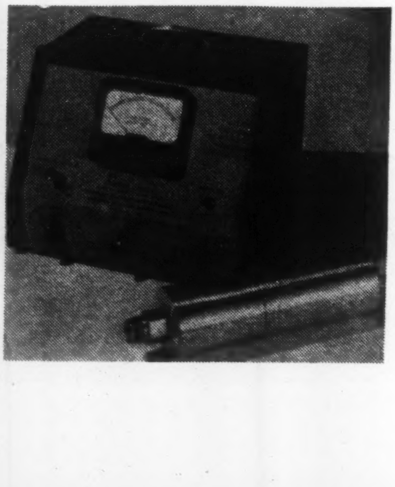
Altimeter Transmitter for Remote Indications

New "Autoflight" transmitting altimeter is combination of "Microtorque" voltage-dividing resistor (*Instruments*, July 1945, page 424) and sensitive altimeter. Since "Microtorque" device requires only 2 gram-millimeters to overcome friction, error from this source is negligible and new transmitter can be used for remotely indicating altitude, to operate recorders and other flight test equipment. Illustration shows method of attaching, with featherweight arm of "Microtorque" attached to pointer of altimeter.—*G. M. Giannini & Co., Inc., Pasadena, Calif.*



Wide-range Vacuum Gage

New "Alphatron" is an all-metal ionization gage with continuous linear response to 10 mm. Hg total pressure. Ionizing agent is a stream of alpha particules emitted by a radioactive source, which permits its oper tion at any pressure, including atmospher without damage to the gage. The stea emission characteristic of the radioacti element and advanced amplifier design a said to assure great stability and to mi mize needle flicker. Model produced at pre sent covers from 0 to 10 mm. in thr ranges, all reading direct pressure. Rang are 0 to 0.1 mm., 0 to 1 mm., and 0 to mm. Pressures can be read to 1% of fu scale reading in each case. New gage said to be ideal for measuring pressures gases other than air, such as argon, wat vapor, and hydrogen, as its linear respon holds true regardless of the atmosphere. *Vacuum Engineering Div., National R search Corp., Boston 15, Mass.*



Electrical Pressure Transmitter

New "SR-4 Pressure Sensitive Devic is used to convert gas or liquid pressure electric energy for remote indicating, recor ing or controlling. Accuracy of 0.25% full-scale makes devi suitable for control oper tions that "heretofore hav not been possible." It available in several rang up to 0-20,000 lbs./in. Output, being electrical, ca be transmitted long di tances for direct readin recording or control. Tran mission even by radio feasible. Principle of co version of pressure chan into current change is sem mechanical, semi-electric (non-electronic): a fi filament wire is bonded a hollow core of elas metal against which is e erted the gas or liquid pre sure. As the pressure i creases the metal core expands and the fil ment stretches, thus decreasing the dian eter of the wire and increasing its electric resistance. Current flowing through bonde filament is changed in inverse proporti and these current changes show up on th dial or are used to actuate a control syste Filament is sensitive to a "stretch" of th metal core of one-millionth of an inc Therefore, only an extremely small expa sion of the core is required and the co metal is stressed well below its elastic limi which has led to a description of the instr ment as being actuated by the "breathing condition of the metal. A built-in compe sator cancels out the effect of temperatu changes. Device is hermetically sealed, approx. 1" in diameter and 5½" long.—*Southwark Div., Baldwin Locomotive Work Philadelphia 42, Penna.*

Silicone Valve Lubricant

New valve lubricant of which undersigne company is exclusive distributor possesse unusual properties advantageous for a num ber of severe services. This lubricant's vis cosity changes only slightly over a wid range of temperature: it is recommende for working temperatures ranging from 40°F. to 400°F. Owing to its "extremel low" vapor pressure it does not evaporat appreciably even at elevated temperature It is colorless. Its principal services ar steam, hot water, hot air, oxygen, hig

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TABLE OF CONTENTS

The nature of electricity. Movement of electrons conductors. The two-element tube—its use as an mplifier. The triode as an amplifier. Amplifier ap- lications of the triode. Ionization. The thyratron: ow it works. The control function of the grid in yratrons. Methods of control in using thyra- ons. Development of the electron-tube oscillator. ypes of oscillating circuits. Neutralizing elec- on-tube amplifiers. The principles and charac- ristics of the tetrode. The pentode. Principle of e suppressor grid. Principles of the phototube. lectromagnetic radiation and the photoelectric fect. Operation and characteristics of photo- bes. Photovoltaic cells, their characteristics and ow they work. The dynatron principle and the ectron multiplier. The mercury-arc rectifier. ld-cathode tubes. Practical forms of cold-cathode bes. Tubes and their classification. Tube data. mplifier classifications. Electronics in the field f measurement. The principle of conversion in in- rumentation. The use of amplification in meas- rement. Sensitive contacts. Electronic relay cir- uits. Applications of the photoelectric effect in easurement. Light beam linkages. Cathode-ray ction. Oscillator applications in the field of in- rumentation. Conclusion.

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vacuum, also for dilute solutions of mineral acids (except nitric and hydrofluoric acid below 250°F.); hydrochloric acid, natural and synthetic rubbers, acetic acid, anhydride and ethyl alcohol below 250°F. It is available only in soft bulk form for application by grease guns.—*Merco Nordstrom Valve Co., 400 Lexington Ave., Pittsburgh 8, Pa.*

The "Penetron"

Undersigned company has begun manufacturing for sale the "Penetron," an instrument originated by the Texaco Development Co. for measuring the thickness, density and other characteristics of materials by means of reflected gamma rays—a method which is not only non-destructive but permits making measurements of pipe-thickness, for example, from outside the pipe without interrupting the process. Principle is illustrated in Fig. 1 (which is purely schematic and hence does not show actual proportions of component parts). Since pulse-rate at detector depends on nature of material and on its curvature as well as on its thickness, calibration curves are supplied with instrument. Equipment consists of (1) *head*, containing radium source, Geiger-Muller tube detector, shields and pre-amplifier; (2) *control box* containing power supply, amplifier, pulse integrator and measuring devices; (3) a 75-foot connecting cable. Head proper weighs approx. 7 lbs. can be inserted in various holders as shown in Fig. 2. Control box is 16½" × 11" × 7½", weighs approx. 35 lbs. A special circuit integrates amplified pulses to produce a direct current and final indicating instrument is a microammeter. "Penetron" operates on 110-volt 60-cycle a.c., consumes approx. 100 watts in operation. *Ranges:* Thickness of ferrous-alloy walls to approx. 0.75"; of aluminum to approx. 1". Measurement is of average thickness over an area of approx. 1 in.², so that: (a) walls of boilers or processing vessels can be surveyed and contour lines drawn to report corrosion-weakened zones; but (b) pin-holes, etc., cannot be detected. *Other applications*: (1) Liquid level is readily determined by moving "Penetron" head vertically along wall of vessel because air or vapor contributes negligible amount of back-scattered radiation and presence of liquid causes sharp increase in pulses reaching detector. By proper instrumentation it is possible to obtain continuous records of liquid level and also automatic control. (2) Interface between two fluids of different densities is similarly measured. (3) Specific gravity or density of a fluid inside a vessel is determined by affixing "Penetron" head to one location and zeroing for the particular wall thickness and the particular reference density of the processed liquid, after which the microammeter readings can be calibrated in terms of density. Tests through a 0.3" wall showed close check with conventional gravimetric methods; accuracy is of course an inverse function of wall thickness and wall-material density. (4) Determination and control of reactants in chemical processes are similarly accomplished. *Substitution of a neutron source* for the standard radium-capsule gamma-ray source permits accurate measurements of wall thicknesses up to 4" of steel.—*Engineering Laboratories, Inc., 602-624 East Fourth St., Tulsa, 1, Okla.*

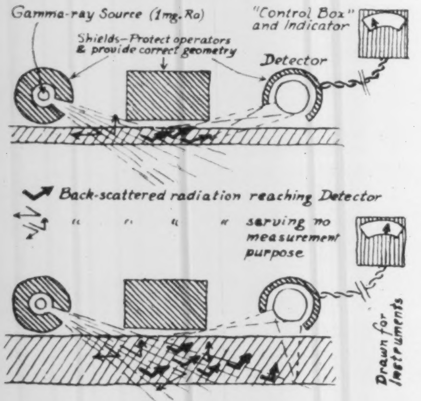

Gamma-ray Source (1mg. Ra)
"Control Box" and Indicator
Shields—Protect operators & provide correct geometry
Detector
Back-scattered radiation reaching Detector
" " " " serving no measurement purpose
Drawn for Instruments

Fig. 1.

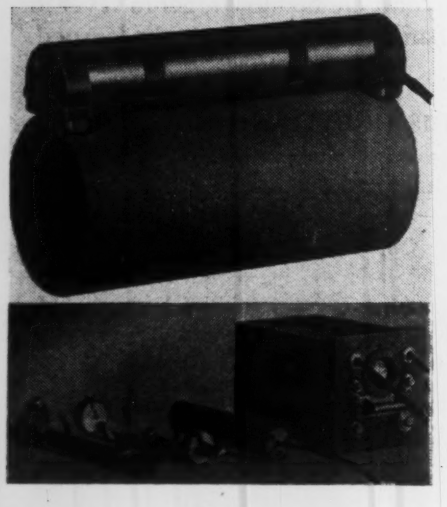


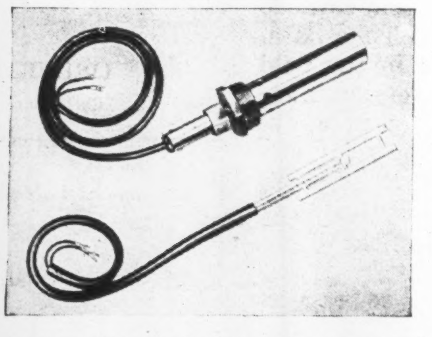
Fig. 2.

Hard-alloy Thread Plug Gages

New thread plug gages are made of "Tantung," a non-ferrous hard alloy. Announcement states that in production-line tests "Tantung" thread gages not only outlasted hardened steel but gave considerably better performance than "other non-ferrous" alloys. "Tantung" is said to be a hard, strong, tough alloy containing cobalt, tungsten, chromium and tantalum-columbium carbide. The latter is said to impart self-lubricating action increasing resistance to wear. "Tantung" is dense and fine-grained. It takes a high finish, is "non-resisting," non-magnetic and not corroded by moisture or by any of "the common acids or fumes." Thread gages and cylindrical plug gages are now being manufactured and many sizes are stocked for immediate delivery.—*Master Gauge Co., 2222 Fenkell Ave., Detroit 21, Mich.*

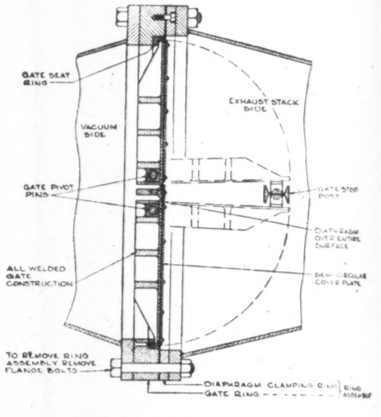
Conductivity Cells

New "CEL-H" dip type electrolytic conductance cell of high cell constant is available in a number of models. Of heavy walled Pyrex and platinized platinum sheet construction, it is made with cell constants of 5, 10, 20, 50, and 100. Because of the unrestricted and wide-bore tubing construction, response to changes in solution concentration is rapid. Glass cell was designed for laboratory use. When mounted in a stainless steel perforated guard tube provided with a 2" standard pipe thread, the "CEL-HY" type cells are well adapted to plant use where their high cell constants tend to reduce polarization errors and eliminate the need for frequent platinizations. Use of a high-constant cell for measurements in highly concentrated solutions of acids, alkalies and salts afford numerous advantages — chiefly greater accuracy in measurement by obviating need of special measuring equipment. — *Industrial Instruments, Inc., 17 Pollock Ave., Jersey City 5, N. J.*



Atmospheric Relief Valve for Condensing Turbo-generators

New atmospheric relief valve protects a turbine against exhaust end damage should unit go over to high pressure. New valve is light and compact, requires no access structure, stem, packing gland or water seal. It is so designed that upon reversal of pressure, a very thin lead disk or diaphragm is sheared mechanically by swinging gates (see illustration). This shearing is accomplished well below the allowable turbine exhaust end pressure. Once the valve has been called upon to operate, replacement of the diaphragm is relatively simple. A special non-oxidizing, acid-resistant grease protects all working parts, assuring operation at any time, thus eliminating traditional annual operation. Available in sizes from 6" to 42" to relieve from 10,000 to 550,000 lbs. of steam per hour, this valve is of all-welded construction, and its cost is considerably lower than that of standard relief valves.—*M. L. Bayard & Co., 1959 Indiana Ave., Philadelphia 32, Pa.*

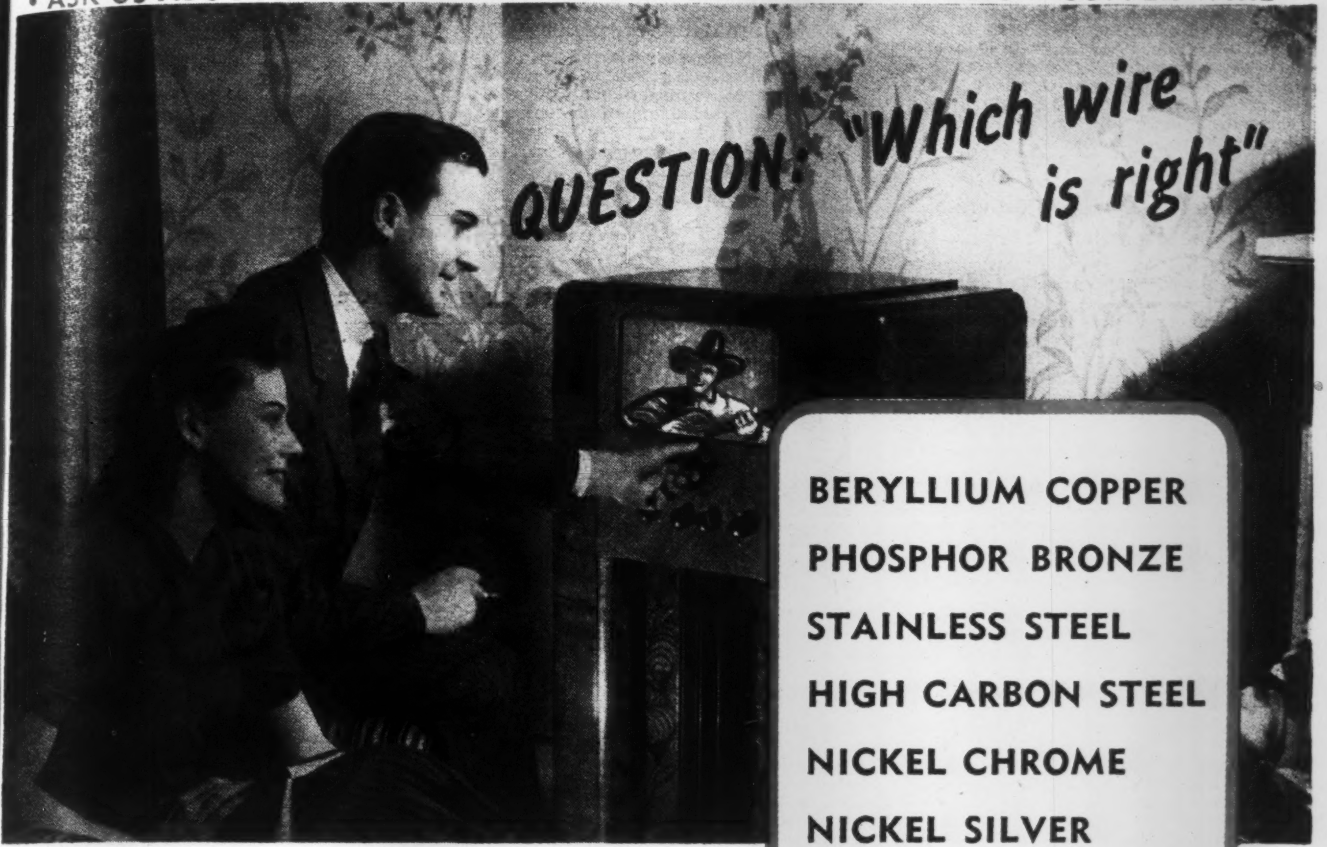

GATE SEAT RING
EXHAUST STACK SIDE
VACUUM SIDE
GATE PIVOT PINS
GATE STOP POST
DIAPHRAGM OVER ENTIRE SURFACE
ALL WELDED GATE CONSTRUCTION
SEMI CIRCULAR COVER PLATE
TO REMOVE RING ASSEMBLY REMOVE FLANGE BOLTS
DIAPHRAGM CLAMPING RING
GATE RING
RING ASSEMBLY

CROSS SECTION OF THE RING ASSEMBLY WITH THE GATES IN THE CLOSED POSITION. THE DOTTED LINE INDICATES THE GATES IN THE OPEN POSITION WITH THE DIAPHRAGM SHEARED PERMITTING FREE PASSAGE OF STEAM TO THE EXHAUST STACK

Gage-surface Protective Plastic

New development in the protection of gaging surfaces of plug, thread, and special gages, called "Jan-Seal," consists of a plastic coating applied to the gage by dipping. By forming a tailor-fitted cover over the gaging surface, "Jan-Seal" is said to keep the tool in perfect condition during shipment and storage. It is easily removed and replaced

• ASK US ABOUT OUR NEW HIGH-TENSILE STRAIGHT BERYLLIUM COPPER WIRE •



QUESTION: "Which wire is right"

- BERYLLIUM COPPER
- PHOSPHOR BRONZE
- STAINLESS STEEL
- HIGH CARBON STEEL
- NICKEL CHROME
- NICKEL SILVER
- STERLING SILVER

ANSWER: "Only the wire that's made for the job!"

In exact sizes with exacting physical characteristics, Spencer wire brings you the right wire to improve your improved product. Write for folder today — Bring your wire problems to . . .

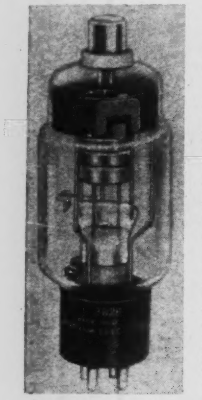
Specify
SPENCER
for exact specifications

SPENCER WIRE

SPENCER WIRE COMPANY
WEST BROOKFIELD PLANT
WEST BROOKFIELD • MASS.

after use, obviating the necessity of coating the gage with grease and then wiping it off. In addition to affording protection against rust and corrosion, "Jan-Seal," to a considerable extent, protects the gage against damage from dropping or being struck. "Jan-Seal" protection is furnished on all Jansson thread plug gages, and on special gages where practical.—*Jansson Gage Co., 19208 Glendale Ave., Detroit 23, Mich.*

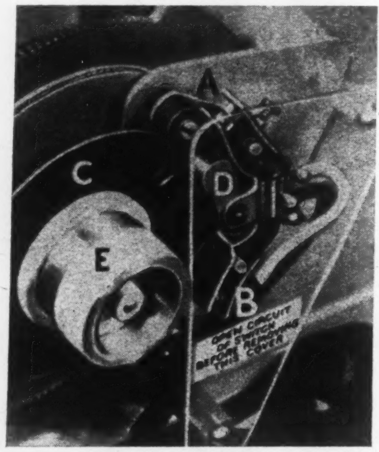
Xenon-filled High-voltage Rectifier



New high-voltage rectifier incorporates many of the desirable features of both the mercury vapor and high-vacuum types: high peak inverse voltage rating, constant voltage drop, heavy current capacity and a wide ambient temperature range—made possible by xenon gas fill and special features of construction. New tube may be operated in any position and is particularly designed to withstand severe mechanical shock and vibration. Element structure is supported by three heavy gage rods and additionally supported by contact—through shock absorbers—with glass bulb. This tube operates through an ambient temperature range of −75°C. to +90°C. *Characteristics* (up to 150 cps): Filament voltage 2.5 volts a.c.; Peak inverse voltage 10,000 volts; Peak anode current 1 amp. at 10,000 volts and 2 amp. at 6,500 volts; Average anode current 250 ma. at 10,000 volts; Average anode current 500 ma. at 6,500 volts; Maximum height 6.38"; Maximum diameter 2.07". *Characteristics* (up to 500 cps): Peak inverse voltage 6,500 volts; Peak anode current 2.0 amps.; Average anode current 500 ma.—*Chatham Electronics, 475 Washington St., Newark 2, N. J.*

Emergency Alarm Feature for Automatic Controllers

New safety emergency alarm feature that protects process equipment and materials has been added by undersigned company to its line of electronic air-operated controllers.


A
C
D
E
B
OPEN CIRCUIT OF SWITCH BEFORE REMOVING THIS COVER

New feature, known as the "Brown ElectroniK Contact Controller," provides safety alarm principles that operate automatically. It also provides on-off control in addition to air control to actuate motorized valves, solenoid valves, contactor panels, signal lights, etc. As shown in accompanying picture, contacts A and B are made or broken by action of cam C and roller D and spring-loaded lever to which it is attached. Control point is set by loosening knurled knob E and rotating cam C, so that its notch corresponds to position of temperature pen that has been previously moved to the desired point. Pen position sounds emergency alarm. A red pointer on the scale (not shown in picture) indicates temperature setting of contact controller.—*Brown Instrument Co., 4482 Wayne Ave., Philadelphia 44, Pa.*

Protected Platinum Thermocouple for Molten Steel

New protected platinum thermocouple, originated by research engineers of Rustless Iron and Steel Corp., is being made by undersigned company. When used in conjunction with special "ElectroniK" recorder, it measures within 45 seconds the temperature of molten steel even when the steel is covered with slag. It consists of (1) an immersion head comprising a platinum and platinum-rhodium thermocouple encased in a fused silica tube mounted in a block of graphite, and (2) a handle in the form of a 12-foot insulated pipe containing wires leading to recorder. In operation, immersion head is manipulated through furnace door into the steel bath. Exposed tip of silica tube, containing platinum thermocouple wires, is immersed in the steel itself but graphite block protects silica tube against deterioration by slag, mechanical shock, etc. Recorder, designed expressly for this application and customarily mounted near furnace, has a large scale; chart rotates at rate of one revolution in four minutes and only during reading. — *Brown Instrument Co., 4482 Wayne Ave., Philadelphia 44, Penna.*

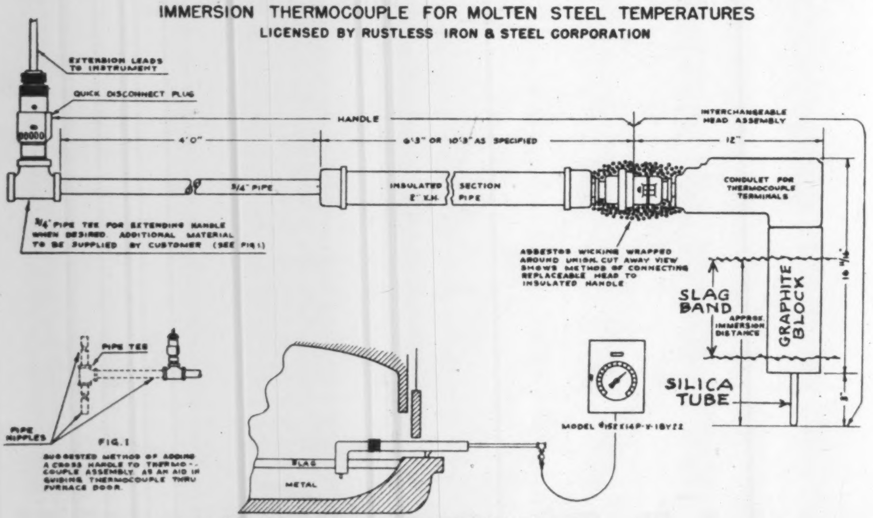
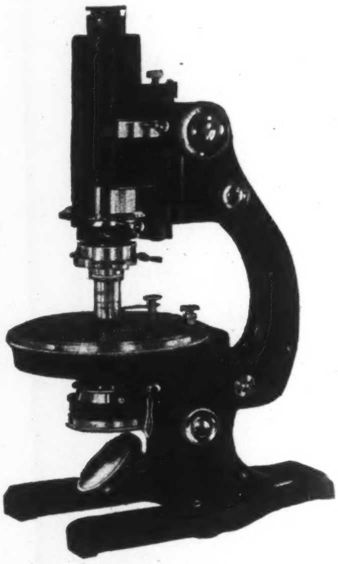

IMMERSION THERMOCOUPLE FOR MOLTEN STEEL TEMPERATURES
LICENSED BY RUSTLESS IRON & STEEL CORPORATION
EXTENSION LEADS TO INSTRUMENT
QUICK DISCONNECT PLUG
HANDLE
INTERCHANGEABLE HEAD ASSEMBLY
4'0"
6'3" OR 10'3" AS SPECIFIED
12"
3/4" PIPE
INSULATED 2" X.H.
SECTION PIPE
CONDULET FOR THERMOCOUPLE TERMINALS
3/4" PIPE TEE FOR EXTENDING HANDLE WHEN DESIRED. ADDITIONAL MATERIAL TO BE SUPPLIED BY CUSTOMER (SEE FIG.1)
ASBESTOS WICKING WRAPPED AROUND UNION. CUT AWAY VIEW SHOWS METHOD OF CONNECTING REPLACEABLE HEAD TO INSULATED HANDLE
SLAG BAND
APPROX. IMMERSION DISTANCE
GRAPHITE BLOCK
SILICA TUBE
PIPE TEE
PIPE NIPPLES
MODEL #153X14P-V-18Y22
SLAG
METAL

FIG. 1 SUGGESTED METHOD OF ADDING A CROSS HANDLE TO THERMOCOUPLE ASSEMBLY AS AN AID IN GUIDING THERMOCOUPLE THRU FURNACE DOOR.

FIG. 2 SCHEMATIC PLAN OF IMMERSION THERMOCOUPLE IN USE

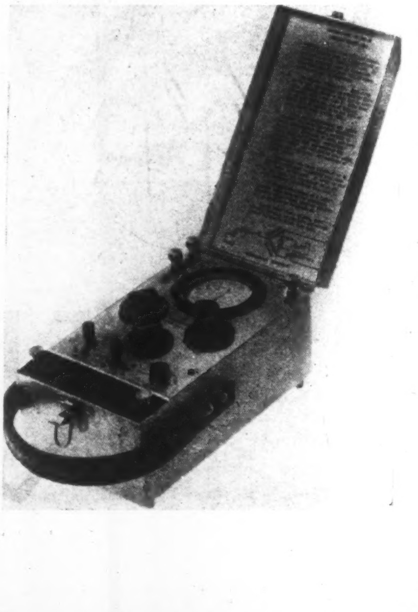
Polarizing Microscope

New "No. 42" polarizing microscope's optical system contains Polaroid material in place of the usual calcite polarizing prisms. Optical characteristics have been found to parallel closely those of calcite equipment. Sensitivity of extinction point compares favorably with calcite, and there is remarkable freedom from residual color. Shorter length of polarizing unit and elimination of several glass-air surfaces reduce the amount of stray light, resulting in a noticeable increase in contrast in the image. This improvement is particularly important in obtaining maximum brilliance for interference figure work. Heavy stand, built for critical work, will satisfy most of the requirements of the petrographer, geologist, mineralogist, biologist and chemical microscopist. With available accessories this new Spencer microscope will meet the requirements of most polarized light microscopy. It is particularly adapted to the needs of the industrial laboratory and is also admirably suited as a teaching instrument.—*American Optical Co., Scientific Instrument Division, Buffalo, N. Y.*



Portable 0-111-ohm Bridge

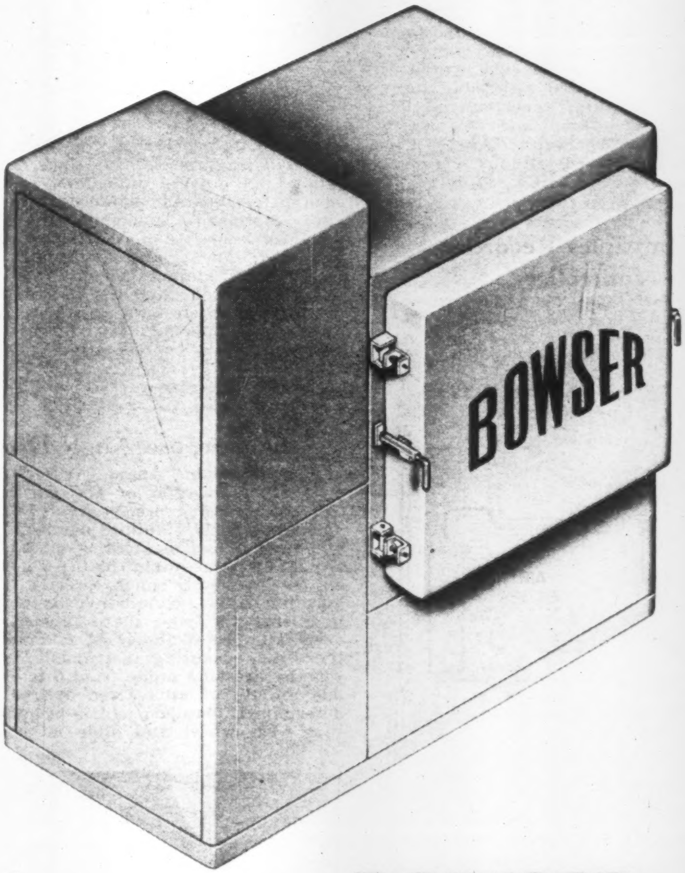
New "Lineman's Bridge" measures 9" × 5" × 4½", weighs only 5 lbs. complete, is built to meet the requirements of the telephone and telegraph lineman. It is used to measure the resistance of wires as well as the unbalance between two wires. Design is such that the reading on the loop can be changed to the unbalance reading without



EQUATOR TO STRATOSPHERE IN A FEW MINUTES

BOWSER
ESTABLISHED 1885

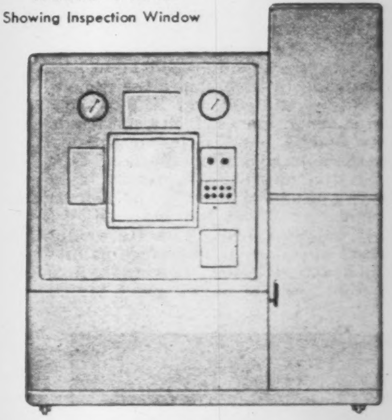
NEW INDUSTRIAL MODEL
Adaptable to Shop Manufacture
or Laboratory Test Operations



SPECIFICATIONS:

- **13 cubic ft. capacity.**
- **Available for three temperature ranges: from +160° F to —50, —76° F and —100° F.**
- **Vacuum pump in base.**
- **Temperature control as usual, by external dial within ±2°F of setting.**
- **Humidity—20% to 95%.**
- **RH optional at slight additional cost.**

REAR VIEW
Showing Inspection Window



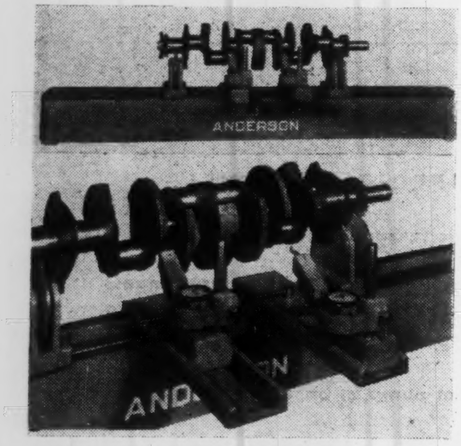
BOWSER, INC.

Mobile Refrigeration Division
1302 E. Creighton • Fort Wayne 2, Ind.

disturbing the connections. This is done in a few seconds by throwing a switch and changing the position of the three decade dials. The switching arrangement also designates which wire is of the higher resistance. The range of measurement is up to 111 ohms in steps of 0.1 ohm with an accuracy of 0.25%. The galvanometer is a Weston Model 375 which has a sensitivity of approximately 22 microamperes per division for 30 divisions. It is an extremely hardy instrument. Batteries are standard 1½-volt flashlight cells so arranged that they can be quickly and conveniently replaced. It can also be used as a general-purpose bridge up to the limit of its capacity.—*Nilsson Electrical Laboratory, 103 Lafayette Street, New York 13C, N. Y.*

Crankshaft-bearing Tester

New "Roto-Checker has been developed especially for speeding up the operation of checking crankshaft bearings. Crankshaft is placed on four rotating disks; a number of indicators are brought into position and the crankshaft is revolved. One indicator can be furnished for each bearing. The four disks roll on accurate "supersensitive ball bearings of Anderson design." The bases are made in two lengths—42″ and 64″. Larger "Roto-Checkers" can be made to suit customers' special work.—*Anderson Bros. Mfg. Co., Rockford, Illinois.*

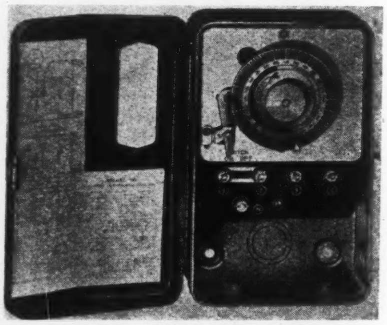


Snap Gage with Built-in Indicator

New "Model 1340" Snap Gage takes the uncertainty out of the conventional "feeler" type of snap gage by visualizing the dimensional variations. In addition it tells how much the dimension varies. It fits the hands comfortably and is handled in an entirely natural manner. It is a single-purpose type of gage, the dial of which is graduated in 0.0001″, has a range of 0.008″, and can be made to suit any dimension between ⅛″ and 1½″. It weighs approx. 7 oz. Its weight rests on rigid upper anvil, therefore cannot influence indicator reading. Lower anvil is a flexible, solid piece of metal which transfers the variation in the dimension from the workpiece to the Dial Indicator. Both anvils are tungsten carbide tipped for long wear. —*Federal Products Corp., 1144 Eddy St., Providence 1, R. I.*

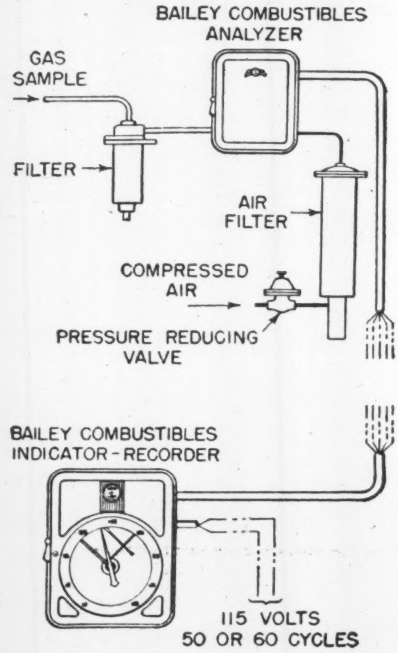
Telechron-motored Time Switches

New "300 Series" time switches incorporate a "Telechron" industrial type self-starting synchronous motor which adds years to the life of the time switch by reason of such features as complete self-oiling lubrication by patented capillary oiling system, practically instantaneous self-starting at full rated load, gear reduction fully sealed to exclude dust and dirt, low power consumption, etc. New "300 Series" units are constructed to give efficient performance, light in weight, small and compact in design, switch capacity of 3000 watts per pole with easily-mounted accessible terminals, skip-trip feature, knockouts on both sides, back and bottom, and two-bearing plate construction. "300 Series" Time Switches may now be purchased without a priority rating.—*Paragon Electric Co., 37 West Van Buren St., Chicago 5, Illinois.*



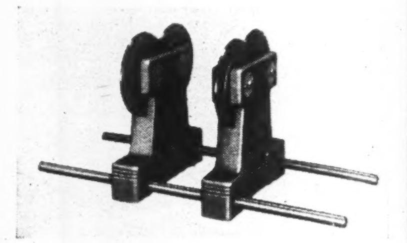
Combustibles Recorder-controller

New automatic analyzer and recorder for indicating, recording and controlling the combustible content of a gaseous mixture provides a continuous graphic analysis almost instantly, is said to be responsive to changes of 0.05% combustibles. Sustained accuracy is said to be within 0.25%. *Operation:* A continuous gas sample is mixed with compressed air and burned on a catalyst-filament which reaches a temperature proportional to the combustible content. Since the filament resistance is a function of temperature, a simple resistance bridge, connected to a null-balance recorder completes the installation. It may be calibrated in percent combustibles, mixture ratio, or other desired terms. Pneumatic control or electric alarm contacts may be provided on both one and two-pen recorders. A two-pen recorder utilizes separate analyzers so that the speed is not impaired by switching, and the two records are independent of each other. *Application:* Combustibles Recorder-Controllers applied to process furnaces operating with reducing atmospheres are said to permit finer measurement and control than has heretofore been considered possible. Variable fuel quality does not affect accuracy of control on installations of this type. —*Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.*



Balancing Ways

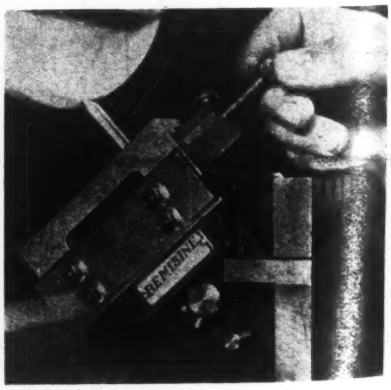
New "Super Sensitive Balancing Ways" are said to revolutionize static balancing operations. Through the use of "scale type" bearings in the small 10″ size sensitivity to 0.007 ounce-inches is made possible. Special sensitive bearings used in the 20″ and 42″ size permit accuracy in balancing to 0.009.

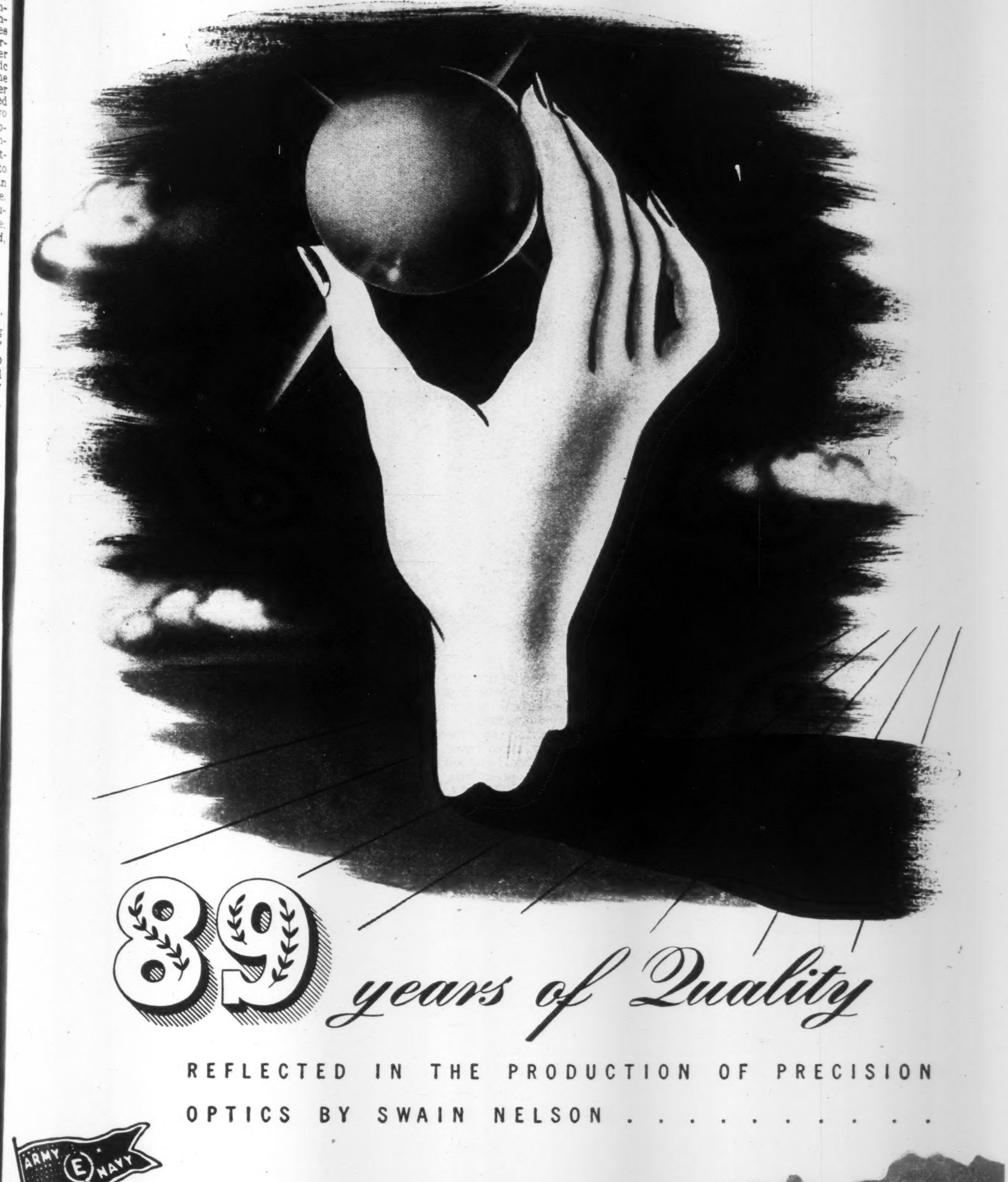


The work is carried on free-turning disks, mounted on precision bearings. Disks are ground on outside diameters, mounted on ground spindles and balanced with extreme care. Standards supporting the revolving disks are movable on shafts to take different lengths of armatures within capacity of machine. Maximum strength and rigidity are obtained through the use of solid end castings. Four sizes are available: 10″, 20″, 42″ and 60″ swing; 400, 1,000, 1,000 and 5,000 lbs. capacity respectively.—*The Ideal Commutator Dresser Co., 1420 Park Ave., Sycamore, Illinois.*

Dual-purpose Angle Dresser

New "Bemisine Angle Dresser" embodies a novel application of the sine-bar principle for dressing precise angles on surface grinder wheels. Sliding member carrying a diamond dressing tool is mounted on an adjustable sine-angle plate which locates on the magnetic chuck directly below the grinding wheel. Sine-bar principle is used in tilting the sine plate precisely to the desired angle. Ordinary 2″ micrometers are the only measuring instrument required to set any dressing angle from 0 to 90° within one minute of arc. After desired angle is determined, diamond tool is brought in contact with wheel and slide is moved back





89 years of Quality

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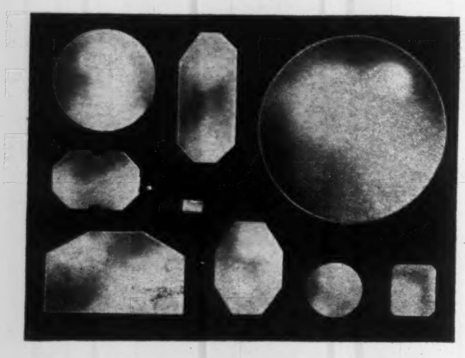
and forth manually to generate corresponding angle on wheel. When not required for angle dressing, sliding attachment can be quickly removed from the Sine-Angle Plate, leaving a working surface prepared for holding small parts at accurate angles for grinding, milling, or jig-boring operations. Device thus serves a double purpose.—*Nichols-Morris Corp., 50 Church St., New York 7, N. Y.*

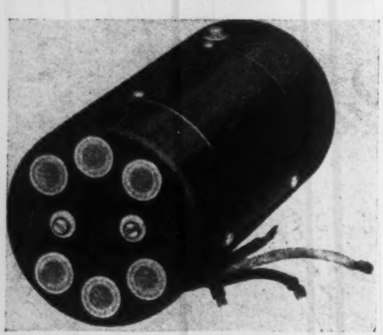
Precision Mirrors and Reflectors

New improved method of producing, to specifications, front- or rear-surface mirrors for precision instruments, etc., is announced. Reflecting surface is produced by new techniques in the thermal evaporation of metals under vacuum. Where unusually high reflectivity is needed, a special aluminum alloy is used. However, mirrors can be supplied in gold, silver, and various other metals to meet specific requirements. The closest optical and dimensional tolerances are maintained. Any size, shape, or thickness, or curvature may be obtained. It is claimed that these mirrors have permanent reflectivity characteristics, will not tarnish, are free of pinholes, and can be cleaned without damaging the surface. The aluminum alloy mirrors are particularly useful because their reflectivity curve is virtually a straight line from the infrared to the ultraviolet. Armed forces are using them in some of their newest optical apparatus.—*Zenith Optical Laboratory, 123 W. 64th St., New York 23, N. Y.*



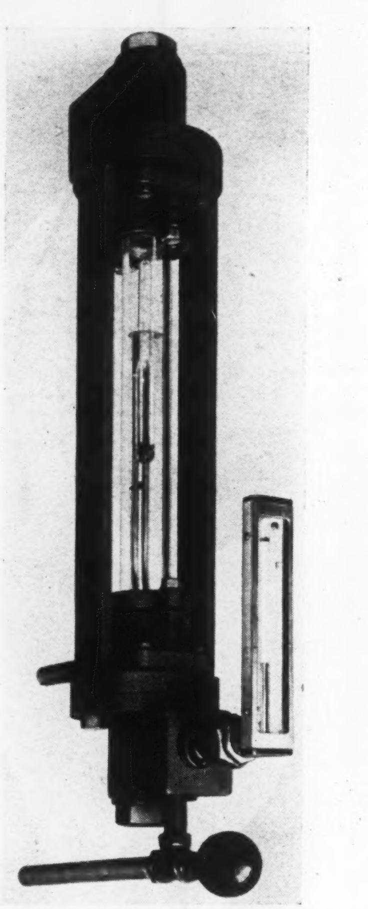
Dynamotors

New dynamotors are announced for aircraft and other applications. Refined design and precision construction are emphasized. Electrical characteristics are said to include low ripple, high efficiency, low drain, a minimum of communication transients and all the "criticals" of importance in airborne power sources.—*Alliance Mfg. Co., Alliance, Ohio.*



Specific Gravity Indicator

New "SK Specific Gravity Indicator" provides continuous indication of a flowing sample, does away with inevitable delay and possible inconveniences of intermittent sampling methods. Flow to indicator is regulated by a valve. Liquid rises in the heavy-walled glass tube to a height determined by outlet pipes, overflows and is returned to the process. Specific gravity is indicated on a standard hydrometer within the tube. An integrally-mounted thermometer permits temperature measurement when hydrometer is read. Indicator is readily installed in new or existing pipe lines. Inside and outside cleaning easily accomplished without disturbing pipe connections. Packing glands are adjusted by cap screws and there are no large threads to corrode and freeze. While normally supplied in bronze, it may be obtained in any alloy on special order.—*Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia 22, Penna.*



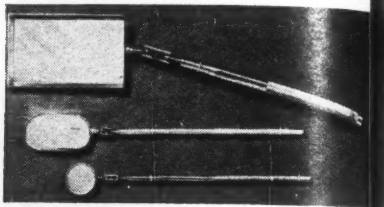
Instrument Motor

New "SM-30" capacitor-start induction motor is available in 1/25 to 1/70 hp. ratings. Diameter 3⅞"; height with rigid base 3⅞"; length of body 4⅞" plus shaft extension. Capacitor approx. 2" diameter by 4" long, may be attached to motor at top, side, or base, or may be mounted separately near motor. Weight 4½ to 7 lbs., depending on rating. Motor is available wound for speeds of 3350, 1725 and 1150 rpm. in capacitor and split-phase, or 3100 and 1550 rpm. as a shaded-pole motor. It can be made with speed reduction gearing. It is furnished with precision ball-bearings or long-life oilless sleeve bearings. Built regularly as a ventilated model, but may be completely enclosed at a reduction in rating. Also built

explosion-proof. Mountings rigid or flexib base, flange, clamp or fastened integrally load. Will operate vertically or in an mounting position when provided with pro er thrust-bearings. Made regularly wi cast-iron housing, but may be made light with aluminum housing. Can also be mad with pressed metal housing. [illegible] made co rosion- and shock-proof. Wound for stan ard power supply voltages up to 460 volt Also made polyphase on special order.—*Small Motors, Inc., 1308 Elston Ave., Ch cago 22, Ill.*

Inspectors' and Mechanics' Mirrors

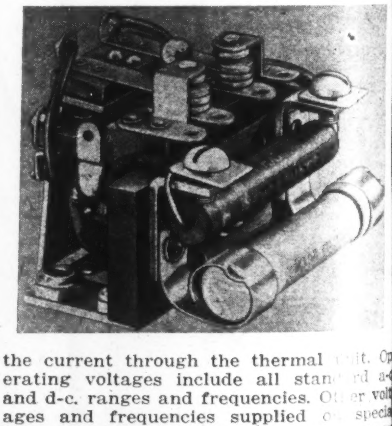
Three new models are featured in maker line of highly-developed mirrors for instr ment work, etc. "Model A-2" is a roun mirror, ⅞" diameter, with all-angle swiv



joint, knurled handle. "Model B-2" is ova 1" × 2", all-angle swivel joint, knurl handle. "Model K-2" is rectangular, 2⅓" 3½", telescoping handle, 15⅝" overall leng open, 6⅝" overall length folded.—*Ullm Products Co., 859 Fourth Avenue., Brook lyn, N. Y.*

Automatic-repeat Brief-interval Timer

New "flasher-interrupter unit" incorporating distinctive design features comprises miniature but heavy-duty relay, an electr thermal timing device and a non-inductiv resistor. Assembled unit is light in weig (only 7 ounces) and extremely compac Four studs are provided for mounting panel, bracket, shelf, etc. with elastic st nuts assuring immunity to shock and vibr tion. Unit is expressly designed to withstand 10 *G*'s in aircraft applications; normally furnished in open design but a required enclosure can be supplied includi hermetically sealed or pressurized typ Interruptions can be controlled through range of 60 to 80 per minute by varyi



the current through the thermal unit. Operating voltages include all standard a-c and d-c. ranges and frequencies. Other voltages and frequencies supplied on specia order. Normal actuating current approx 200 milliamps. Contacts: d.p.d.t. 5 amp (non inductive) at 32 V. d.c. or 115 V. a.c 5 amps. (non inductive) to 220 V. a. s.p.d.t.d.b. 25 amps. (non-inductive at 32 V d.c. or 115 V. a.c. 7.5 amps. (non-inductive to 220 V. a.c. Applications for this devic include aircraft identification lighting, con trol circuit as well as marine, industria automotive and railway signalling devices wherever a predetermined number of inter

HOW CHACE BIMETALS HELPED

Builders of Appliances and Controls

More than twenty years ago Chace developed and introduced thermostatic bimetals made of nickel-chrome steels, which had a longer life at high temperatures than earlier type bimetals made of other alloys.

As a result, the manufacturer of temperature responsive devices was enabled to get a more lasting actuating element and, in consequence, to produce a dependable and more enduring appliance or control. Chace Thermostatic Bimetal thus became "the heart" of many leading temperature indicating and controlling devices whose sales volume steadily increased.

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one of which should precisely fit your needs

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Photo Courtesy of Stanley Tools

USE KESTER FLUXES for Permanence!

- Don't risk service difficulties, mechanical failures, with solder flux that won't hold tight! Chemically correct flux—and different fluxes for different types of operations—are imperative for permanent soldering. That's why Kester fluxes are scientifically compounded to form tight, clean solder-bonds resistant to shock, vibration, bending, contraction and expansion. They insure the lasting quality of your product!
- For over 45 years Kester Fluxes have been tried, tested and proved dependable. There is a wide range of Kester flux formulas to fit every possible solder operation.
- Consult Kester engineers for practical, experienced help in solving any solder problem you may have. They'll gladly suggest the right flux to protect your product—and at no obligation.

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SALTS
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Solder Fluxes
STANDARD FOR INDUSTRY

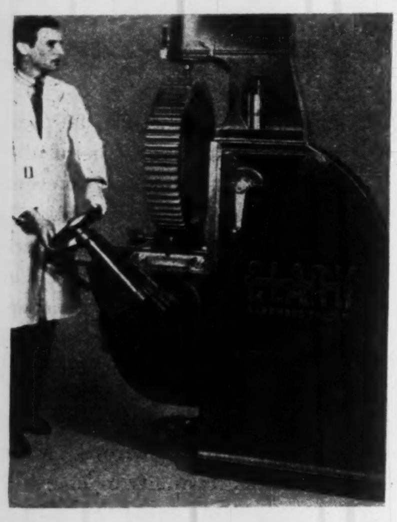
ruptions is desired in any electric or electronic circuit. Dependability and accuracy are said to be assured by sturdy construction and safety factor engineering.—*Electronic Testing Laboratories, 44 Summer Avenue, Newark 4, N. J.*

Automatic Feeder for Control of Grinding

New feed regulator for hammer mills, attrition mills and cutters permits handling full production loads by doing away with the guesswork of human control, makes it unnecessary for operator to watch feeding and manually regulate the feed to avoid overloads and mill choke-up. Regulator maintains load on pulverizing equipment at maximum rated capacity of the connected motor. Design prevents momentary overloads from actuating or disturbing the feed control relay. An underload light signal indicates failure of material to reach pulverizer owing to empty bins or arching at some point in flow above feeder. Additional light or sound signals can be wired to any required location.—*Mosher Electronic Controls, 130 W. 42nd St., New York 18, N. Y.*

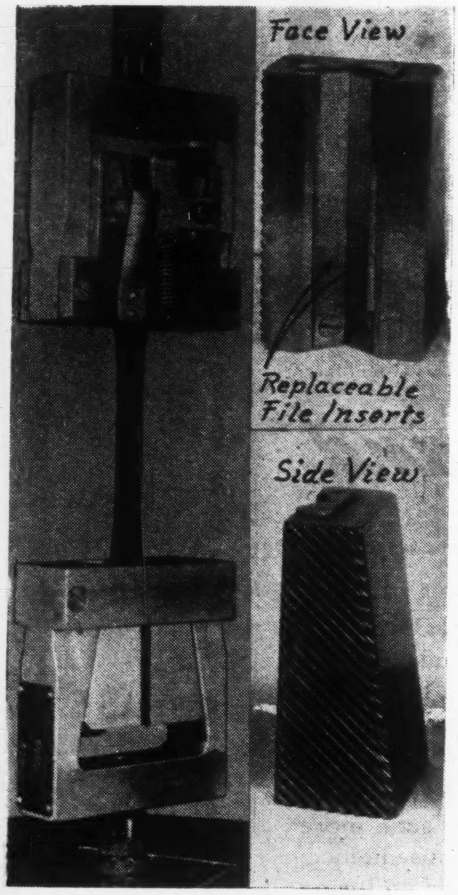
26″-capacity Hardness Tester

New large model of the Clark Hardness Tester for Rockwell testing is designed to handle large or cumbersome parts, ranging from ½″ to 26″. It gives a true Rockwell reading, using either a diamond or steel ball penetrator, both furnished as standard equipment. Provision is made for raising or lowering table by means of a hand crank. Position of capstan, mounted on side of machine, may be correspondingly adjusted in relation to table height. Heavy parts are loaded onto a roller bearing carriage on the table, providing an easy method of positioning. Readings are taken exactly as with the ordinary Rockwell tester. By means of the capstan the indicator is set at zero on the minor loads. The major load weight is released and a direct hardness reading is taken from the indicator.—*Clark Instrument, Inc., 10200 Ford Road, Dearborn, Mich.*



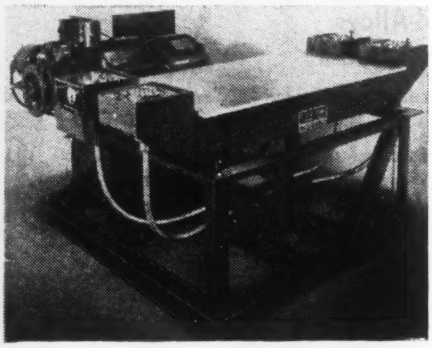
Testing-machine Grips for Smooth Hard Plastics, etc.

New special plastics grip, designed on the Templin principle for use with universal testing machine, is of 5000-lb. capacity, weighs 4½ lbs., is self-aligning (swiveling and laterally) and its basic principle makes it particularly good for gripping the glassy-hard surfaces of some plastics. Another development in this field is a new wedge grip with a replaceable file face for use in testing machines up to 300,000-lb. capacity. This feature saves replacement of an entire grip when the teeth are worn or broken. Grips are available in flat type for tension testing of flat specimens and in vee type for testing round specimens. General construction is same as conventional grip except that front has been slotted to permit insertion of removable specially-made file face. Since tooth spacings of ten, sixteen and twenty-five to the inch are available, new grips make it practicable to keep a stock of faces adaptable to various types of material that may be tested. Because toughness is as important in a grip as hardness, new grip will be particularly valuable for testing "very hard" specimens and materials such as music wire.—*Southwark Div., Baldwin Locomotive Works, Paschall Sta., Philadelphia 42, Penna.*



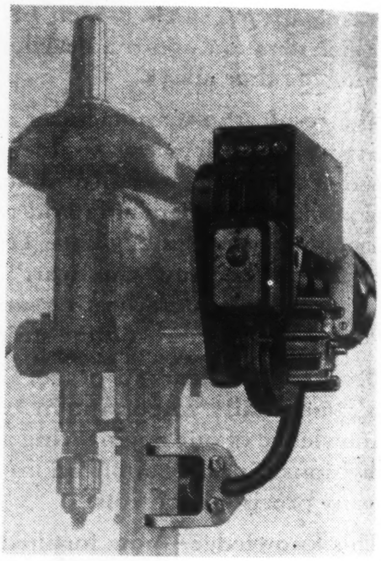
Vibration Test Table

New "RV-3 Vibration Test Table" is of the reaction type. Table top is supported by four vertical rods acting as flexing columns to permit free table vibration in the two horizontal directions. Four sets of rotating eccentric weights induce rectilinear and pure harmonic vibrations. These weights, mounted on vertical shafts, are driven by a variable-speed drive through a synchronizing gear box and flexible shafts. Amplitude (⅛″ maximum excursion at 100-lb. table load) and direction of vibration (horizontal crosswise or lengthwise) are adjustable when machine is not running. Increase in load over 100 lbs. automatically reduces amplitude. Standard frequency range is 10 to 60 cycles per second, which is adjustable while running, either by hand wheel or ¼-h.p. motor-driven automatic frequency change control, with one-minute complete cycle. Amplitude does not vary with frequency. An acceleration of 10 G is produced between 50 and 60 cycles per second at ⅛″ double amplitude. Equipment has a maximum capacity of 400 lbs., weighs 1500 lbs. and is operated by a 5-h.p. motor. Overall dimensions 52″ × 58″ × 32″ high. Table top is 24″ × 40¾″. Installations can be made on upper floors of buildings without concrete bases.—*L.A.B. Corp., Summit, N. J.*



Automatic Feeder for Control of Deep-hole Drilling of Small Holes

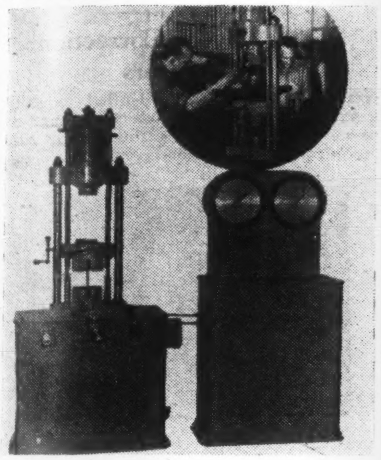
New "Pre-Selectric Power Feeder" automatically duplicates the operations of a skilled mechanic when deep drilling or tapping small holes, providing automatic chip clearance at pre-selected depths during the drilling or tapping operation. It mounts by a bracket on the drill press column and by attaching a collet to the drill press spindle feed shaft. Its positioning is not critical. Weight of unit is balanced on its support arm, no weight being added to the drill press spindle feed shaft bearings. Installation can be accomplished in less than ten minutes by one man. Announcement states that new "Pre-Selectric" feeder will consistently drill 250 holes through alloy steel plate to full length of drill without drill breakage and with substantially less dulling of the drill than when controlled by hand. All controls are conveniently reached from operator's normal position (see illustration). Switches at top of panel are: (1) On-and-off switch for automatic operation; (2 & 3) up-and-down control switches, the "down" switch starting the cycle and the "up" switch reversing the spindle, returning it to the up position at any desired point in the operating cycle; (4) main power switch. Lower row of edgewise control dials are the limit dials controlling depth of drill as to top and bottom limits and extent to which drill is raised for chip clearing. Drill may be partly or fully raised from the hole to clear chips. Automatic timer controls length of drilling time between chip clearances. Pressure adjusting knob (at right of timer) sets amount of pressure on drill, thus controlling rate at which drill is fed into work. Unit operates on 110-volt single-phase or 220/440 three-phase supply. In operation the "Pre-Selec-



tric Power Feed" provides timed, reversible, adjustable torque with automatic start of the cycle and automatic stop; and retracts the drill for full chip clearance at a preselected point. When used with any standard tapping head, unit becomes a precision automatic tapper: tap is lifted high enough for chip clearance, but not completely removed—of advantage in blind tapping. Unit is also used for honing, lapping and reaming. Unit permits hopper-feed of work to the drilling fixture with the operating cycle controlled by energizing a circuit through the "Pre-Selectric Power Feeder" to assure proper positioning of the work, with electrical interlock.—*James H. Knapp Co., 4921 Loma Vista Ave., Los Angeles 11, Calif.*

Universal Testing Machine

New "Model MP-10" hydraulically-operated universal testing machine is designed for the making of tensile, traverse and compression tests up to 60,000 lbs. Piston and cylinder are lapped-finish, carefully fitted without any packing, allowing for a minimum of friction. Pulling head unit thrust is taken on a large steel ball-and-socket which allows the head to float. Upper and lower pulling heads are of conventional type with wedge type jaws for both flat and round specimens. Holders are also available for shoulder and thread-end specimens. Load regulating valve is provided which will maintain a uniform load rating. Any load can be held for any period at will of operator. Both gages are provided with maximum pointers; both are fully protected against overload; gage selector valve is provided. A maximum stroke of 6" is provided in the cylinder. Traverse table has a maximum span of 30". Equipment consists of: motor, hydraulic pump, necessary valves and gages. Main illustration shows machine set up for tensile test; thumbnail shows operator about to take a transverse reading.—*Steel City Testing Laboratory, 8843 Livernois Avenue, Detroit 4, Mich.*



Motor-driven Dry Air Pump

New "Type 1511" motor-driven explosion-proof dry air pump requires no lubrication, is designed to provide air pressure or suction for instrument operation, camera operation, noxious gas detector operation, radio harness pressurization, etc. It provides a theoretical air flow of 4.1 cfm at 10,000 rpm and is driven by an integral 0.2 bhp 27.5-volt d-c. explosion-proof motor. Rated capacity

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TELEVISO Series 200A VT Voltmeter

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SUPERSENSITIVE RANGE—the lowest readable voltage is .05 volts on a maximum scale range of .5 volt.

FIVE VOLTAGE RANGES—.5, 2, 15, 50, 150—spread full scale on a 4½" meter dial for easy reading. Accuracy of readings are 2% full scale; middle scale accuracy is 5% or better.

PROBE CONSTRUCTION—detachable probe to eliminate cable wear; easily dismantled for tube replacement or for soldering to tube terminals for measurements in the 250-500 MC region; flat ½" wide brass terminals connect to input to make easy soldering to test or work piece; for low frequency work up to 100 MC, removable banana plugs are spaced ¾" center to center for use with standard jacks.

MECHANICAL CONSTRUCTION—of aluminum throughout; panel and cabinet are ¼" thick (cabinet is dural.); sub-chassis is ⅛" and spaced off the panel by studs to simplify servicing; all components are fastened to sub-chassis.

ELECTRICAL CONSTRUCTION AND CIRCUIT—Series 200A utilizes the finest components throughout and carries a two year guarantee. The circuit is a stable plate circuit rectifier. No diode input tube is used. The plate circuit rectifier type makes available higher input impedance at all frequencies. No shortening of input probe is required for zero adjustments. All zero adjustments are made once and remain constant. A panel adjuster is available to make the unit usable without heating up time. All filament and plate voltages are transformer and tube regulated.

BUILT-IN CALIBRATION VOLTAGE—All units have a jack which produces a constant 6.3 volts for standardizing. This is the regulated filament voltage. The sensitivity can be adjusted without tools in the event tubes are replaced in the field. The Series 200A will operate satisfactorily from any source of voltage from 95 to 130 volts ac. Line voltage surges are not observable during use.

SIZE 14"H x 9½"W x 7½"D. Guaranteed 2 years. Price $170.00 F.O.B. Chicago.

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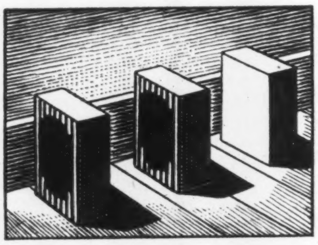

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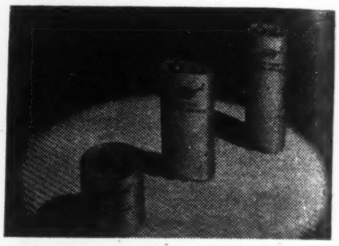
is 0.018 lb./min. air flow at [illegible]1" Hg abs. inlet pressure, maintaining 3[illegible]" Hg abs. discharge pressure. Maximum operating characteristics: current draw, 15 [illegible] pressure differential, 20" Hg; discharge temperature, 300°F.; minimum flow, 0.01 [illegible]n. New construction, said to be exclusive, eliminates oil filters, separators or accumulators and provides air which is free of oil contamination. This eliminates explosion hazard in applications where electrical discharges occur. Since pump requires no lubrication, it can be mounted near its supplementary equipment or in inaccessible places. Pump is a rotary single-vane type, vane being held against rotor by pressure exerted through dual helical springs. Finned rotor housing design dissipates heat rapidly. Automatic electrical overload protection is incorporated and provisions for wiring connections through electrical connector fitting AN-3102-16-11P. Unit weighs 4.7[illegible] lbs.; measures 8-21/32" long by 3-17/32" diameter.—*Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.*

Power Factor Correction Capacitors

New oil-impregnated oil-filled capacitors are said to embody the electrical and mechanical design features found best suited to requirements of fluorescent lamp service.



Operating temperatures range from −67°F. to +185°F. Oil-tight terminals are insulated with sturdy phenolic bushings and provided with tinned copper soldering lugs. Available sizes include capacitances from 2.0 to 5.25 mfd. and working a-c. voltages from 165 to 440. Standard capacitance tolerance of Tobe capacitors for fluorescent lamp service is −0 +20%. Wide variety of mountings.—*Tobe Deutschmann Corp., Capacitor Div., Canton, Mass.*

Volt-ohm-milliammeter

New "Model 625-N Volt-Ohm-Milliammeter" gives maximum testing facilities plus greater sensitivity. D-c voltage ranges with dual sensitivity (10,000 and 20,000 ohms per volt) provide double the number of full scale readings of the average tester. 0-1.25-

CAUTION ON HIGH VOLTS
COMMON
OUTPUT
OHMS ADJ.

5-25-12[illegible] 0-2500 d.c. volts, at 20,000 ohms per volt and 0-2.5-10-50-250-1000-5000 d.c. volts, at 10,000 ohms per volt. Current ranges [illegible] d.c. microamperes; 0-1-10-100-1000 d.c. milliamperes and 0-10 d.c. amperes, [illegible] 50 mv. Resistance ranges 0-400 ohms ([illegible] at center scale); 0-50,000 ohms (300 at center scale); 0-10 megohms (60,000 ohms at center scale). Direct-reading output level decibel ranges −30 to +3, +15, +29, [illegible] +55, +69 db. A capacitor is in series with a.c. volt ranges for output readings. The large 6" sensitive indicating instrument carries a lifetime guarantee against defective workmanship or material. A long [illegible]" scale provides excellent readability for all ranges. The compact, black, molded case, 6" × 5½" × 2½", is furnished with leather strap handle for portable use. Test leads and accessories furnished.—*Triplett Electrical Instrument Co., Bluffton, Ohio.*

Vibration Pick-up

New vibration pick-up was developed to meet the requirements of aircraft engine testing, is said to possess exceptional durability under conditions of extreme vibra-

VIBRATION PICKUP
TYPE 124 SER NO
HOR
THE MB MFG. CO. INC.
MADE IN U.S.A.

tion, high output signal level, freedom from frictional effects limiting response at low amplitudes, and stability of calibration over wide temperature ranges. Output is proportional to vibratory velocity, with uniform response from below 10 cps to appjrox. 1000 cps., and usable response to 4 cps. New pick-up is usually operated as a seismic instrument, but can be furnished with provision for direct attachment of the extremely light moving coil to structure whose vibration might be influenced by a heavier mass. Pick-ups are furnished with a special flexible pigtail lead, and are easily and quickly converted for use in either horizontal or vertical planes without affecting calibration. —*The MB Manufacturing Co., Inc., New Haven, Conn.*

Specimen Shear for Stiffness Tests

New "No. 104-11 Triple Cut Specimen Shear" was designed for use with maker's "V-5 Stiffness Gauge" to assure accurate cutting of test specimens (1½" × 2¾") for

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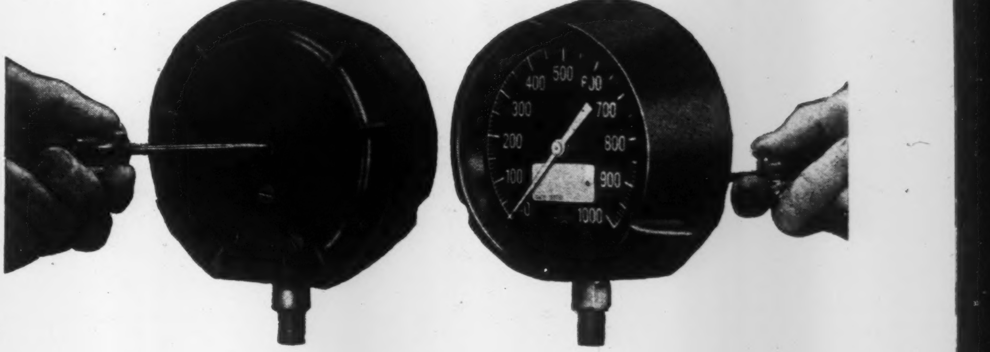

Another exclusive feature of the Certified Gauge is the Hairline Pointer Adjuster. You can now reset your pressure gauge pointer externally from the back of the case, without removing the glass or pointer. Very convenient when testing gauges on a test pump or dead weight tester.

A slight turn with a screw driver rotates the roller pinion of the Helicoid movement and adjusts the pointer to the desired dial reading. The Hairline Adjuster cannot be jarred out of position. Only Certified Gauges are made with the external Hairline Pointer Adjuster.

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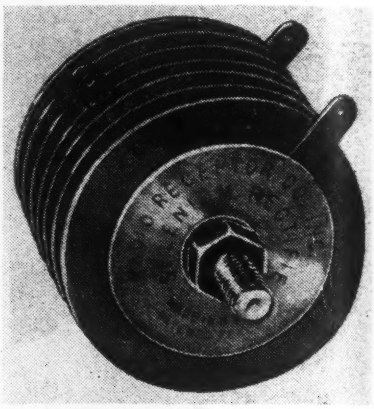
uniform and comparable test results. Shear will cut 0.020" paper, plastic [illegible] thin metallic sheet and foil in preparation [illegible] of stiffness or resilience test. Test strip [illegible] cut and detached from a sheet in one operation by placing straight edge of sample sheet against back gage of Shear [illegible] pushing down with a quick motion.—[illegible] Instrument Corp., North Tonawanda, [illegible] Y.*

Auxiliary Weights for Stiffness Tests

Announcement is made of availability of extra auxiliary weights for making "V-5 Stiffness Gauge" in 3000 and 5000 units, extending the testing range of this instrument to cover twice capacity of standard units.—*Taber Instrument Corp., North Tonawanda, N. Y.*

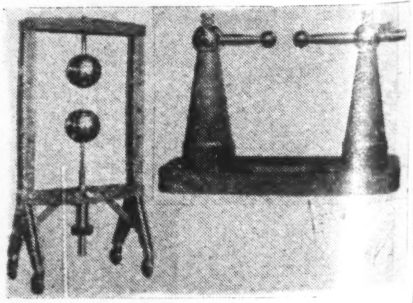
Selenium Rectifiers

New selenium rectifiers are said to meet every requisite for a modern a-c. to d-c. conversion unit. Announcement states that after intensive research for more than two years, maker has enhanced advantages of selenium type units by utilizing, in the main, aluminum in place of iron or similar metals, and by developing a method of sealing unit hermetically. Use of aluminum reduces unit weight by two-thirds, enables vastly more efficient heat dissipation and provides for an increased margin of protection beyond normal plate rating. New line embraces a wide range of units, from 25 milliamperes to hundreds of amperes, for every industrial application, for all combinations of voltage and current outputs and for various types of circuits. Among applications are battery charging, relay circuits, welding, electroplating, magnetic devices, telephony and railway signaling.—*Radio Receptor Co., Inc., 251 West 19th St., New York City.*



Sphere Gaps for High-voltage Measurements

New complete line of sphere gaps, for measurement of high voltages used in a-c or d-c. testing, comprises standard diameters of 2, 6.25, 12.5, 25, 50, 75, and 100 cm., for spark-over voltage ranges of 8.5-45 to 261-1338-kv. crest. Sphere gaps are furnished



complete with current-limiting series resistance assemblies. In addition to providing the most direct method of gaging test voltages, the gaps serve as protective devices to prevent overvoltage on the test specimen or apparatus during high-potential testing. They also offer the following advantages: Indicate crest voltage regardless of wave form; relatively unaffected by humidity changes in the air; have practically no time lag; and spark-over voltages are very consistent. The 2- and 6.25-cm. gaps are both of the table-type, with electrodes mounted horizontally in wooden supports. The larger sizes are of the floor type with highly polished spheres mounted vertically in a rectangular frame. All are provided with precision adjustments for gap spacing. Sphere gaps of 25 cm. and larger can be provided with casters for easy mobility, and a motor drive for gap adjustment if desired. The current-limiting resistance assemblies are made of non-inductive, wire-wound rods mounted on treated wooden frames.—*Transformer Div., General Electric Co., Pittsfield, Mass.*

Direct-reading Insulation Tester

New "Model 799 Insulation Tester" is an extremely sensitive direct-reading device for applications where high testing potentials are not desired. Extreme sensitivity is result of use of new electronic circuit with tube amplifier operating on grid conduction principle. It provides a single wide range for readings from 0.1 megohm to 10,000 megohms, with the 10,000 mark at 8% of the scale length (0% representing infinity) thus providing good readability. Circuit has a test potential of less than 50 volts d.c. An electrical guard circuit is provided for elimination of surface leakages when testing cables. In electrical testing, "Model 799" is said to replace expensive or specially-built test stands, for checking leakage between windings in transformers, cable resistance, leakage of low-voltage paper and mica capacitors without damaging the dielectric, and for numerous other tests. Dimensions, 5⅝" × 3¼" × 4⅞". All exposed metal parts are thoroughly insulated for operator's protection. A "press-to-read" switch automatically disconnects battery circuit when not in use. Ferrules in panel permit attachment to lineman's belt or shoulder strap.—*Weston Electrical Instrument Corp., 617 Frelinghuysen Ave., Newark 5, N. J.*

LINE
SHIELD
GROUND
MEGOHMS
WESTON
MODEL 799
INSULATION TESTER
ZERO
ADJUSTER
TO READ

Voltage Supply Units

New "Type W Vari-Formers" for laboratory and industrial use are double or isolation wound. They have a primary wound for 115 volts input and a variable secondary wound for an output of 0-130 volts. Separate terminals are provided for primary and secondary windings for full flexibility. It is therefore possible to connect these units as autotransformers making several different voltage combinations

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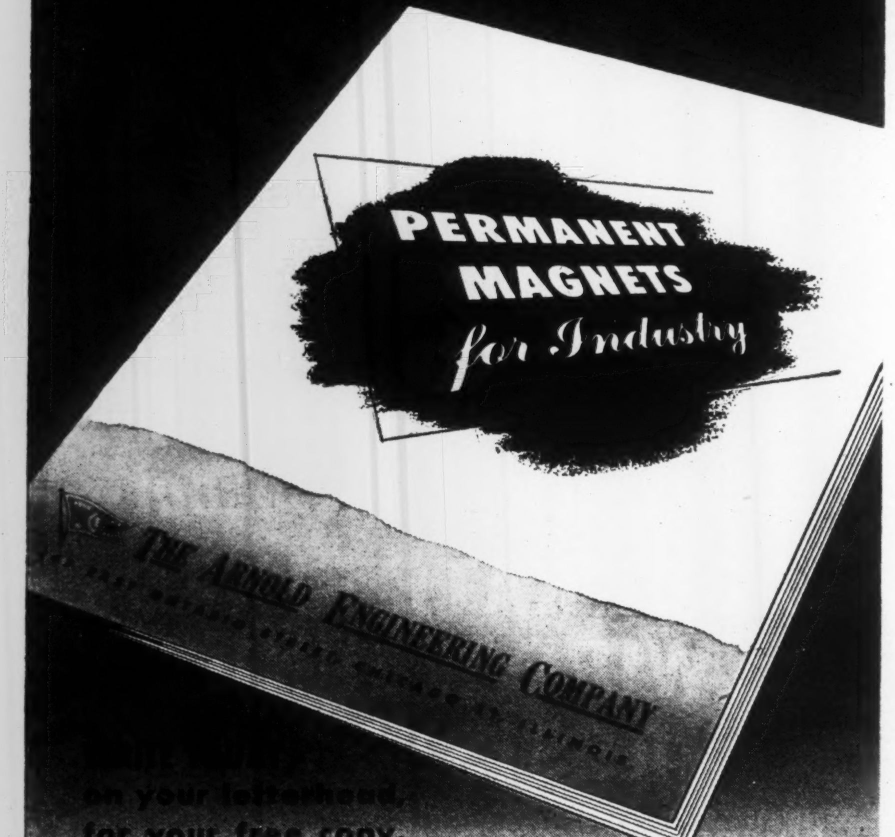
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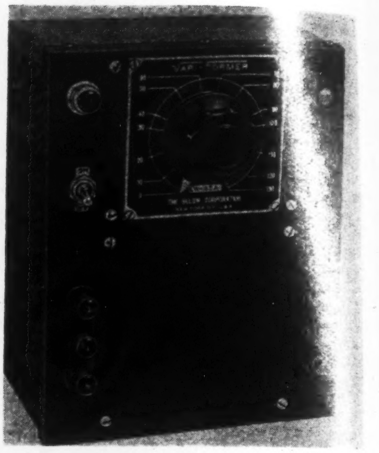
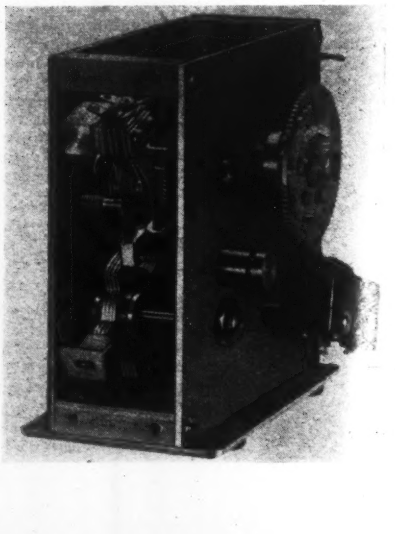


possible. Inputs of 115 or 220 volts can be applied and output ranges of 0-65 or 65-130 are obtainable with increments of 0.3 volts. Likewise output ranges of 0-130 or 115-245 with increments of 0.6 are possible. The separate primary and variable secondary windings are wound on the same core, resulting in excellent regulation and obviates the necessity of using two transformers to obtain an isolated variable voltage supply. For critical electronic testing and special applications an electrostatic shield has been imposed between the primary and secondary; grounded to the core and brought out to a separate terminal. These units have the same high overload capacity as the "Type C" (auto-transformer) "Vari-Former." Units with capacities of 500 va. to 2000 va. are available. The 500 va. measures 7" × 9" × 4½" deep; weight 20 lbs. The 2000 va. measures 10" × 10" × 8" deep; weight 50 lbs. Sliding silver contactor, of same construction as in all "Vari-Formers," assures long life, constant contact drop and resistance to corrosion—important factors where adjustment of voltage is infrequent or high humidity prevails. Custom designs can be supplied to meet unusual electrical and mechanical requirements. Unit illustrated is "Model LW 43 AX," capacity 600 va.—*The Gulow Corp., 26 Waverly Place, New York 3, N. Y.*

Constant-speed D-c. Instrument Motor

New constant-speed d-c. motor is said to give a-c. advantages with batteries or d-c. line, is small enough to be held in palm of hand. New motor is especially adaptable to synchronous operation formerly possible only through the use of a-c., maintains a constant set speed regardless of wide variations in voltage. It is self-starting and "builds up full speed almost instantly." Current consumption is extremely low (from 0.06 to 1 watt), and shaft speeds may be



geared [illegible]m 1 revolution every 24 hours up to 60 r.p.m. It is claimed to provide the same time-keeping accuracy with direct current that a-c. motors give with alternating current. It is available for use at 1½, 3, [illegible] 12, 24, 32 or 110 volts. Constant speed is said to be maintained even in the case of storage battery operation where voltage is higher when battery is being charged.—*Amglo Corp., 4234 Lincoln Ave., Chicago, Ill.*

Automatic Ball Sorter

New automotic ball sorter has been developed to provide perfectly-sized and perfectly-matched balls for better and more accurate bearings, and to sort them faster. When fed commercial balls, which have already been graded to a tolerance of 1/20,000 inch, this automatic machine sorts them into groups five times more accurate. As many as ten size selections can be made—each group being separated by ten millionths of an inch. Operation consists only in filling the Plexiglass hopper and removing the sorted balls. Manufacturer's officials state that one operator can handle four machines easily, and that each four machines sort more balls than 32 skilled operators using the conventional measuring equipment—and do it far more accurately.—*Electronics Department, Jack & Heintz, Inc., Cleveland, Ohio.*

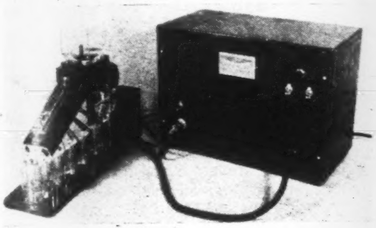


Fig. 1

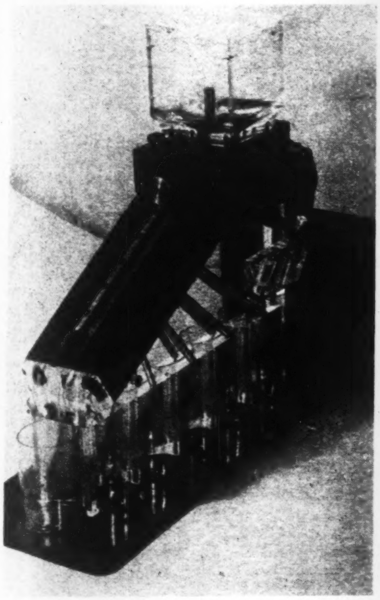


Fig. 2

Regulated Power Supplies

New series of saturable-reactor-regulated power supplies has been developed for all applications requiring d-c. voltages regulated to better than 5% from full-load to no-load, and having less than 1% ripple under full load conditions. Included in this new series are eleven standard power packs for voltages of 24, 48, 36, 110, 120, 135, 250 and 500; 8 amperes to 0.2 ampere; may be furnished with built-in automatic voltage regulators to compensate for line voltage changes. These units may be used as storage

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A striking example of Balac's many uses is the conversion of standard Wheatstone bridge instruments to AC. AC accuracy and performance become equal to DC operation on the same instrument. Null indication is never affected by temperature, frequency, wave form or line voltage changes.

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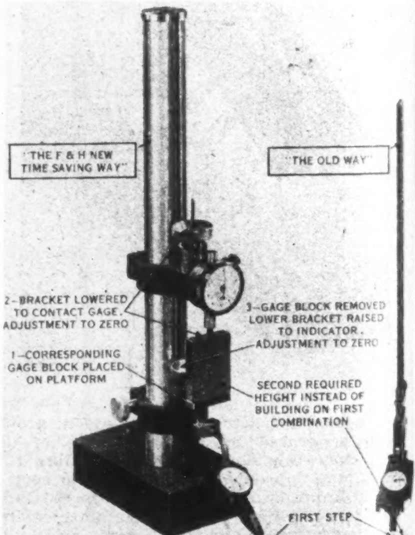
battery substitutes or to replace d-c. generators. Multiple units find application in place of high-current generators previously used to supply special voltages over a large area. Use of individual packs avoids two common troubles encountered with central

supply stations: (1) total failure of voltages; (2) interaction between test positions. It has also been found that the use of low-current supplies provide an appreciable saving in special wiring normally required for high-current lines. A wide variety of a-c. voltage regulators are also available. All units have been carefully designed with generous overload safety factors. Power packs employing heavy-duty rectifier tubes are provided with built-in thermal time delay relays which apply plate supply voltage approximately 30 seconds after rectifier filaments are heated. All power packs are equipped with recessed male receptacles, female outlets, power line switch, pilot indicator and fuse.—*Amplifier Co. of America, 398 Broadway, New York 13, N. Y.*

Height Gage

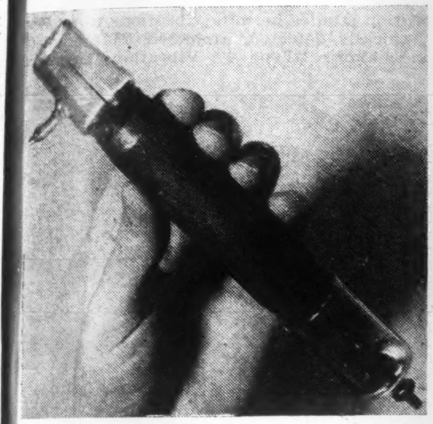
New design of "F & H Height Gage" gives greater capacity (30″) and considerable saving in time (over 50%) as compared with "old way." Its use is said to eliminate various conditions which influence accuracy when checking with a conventional height gage, such calculations, accumulations of gage block combinations and difficulty in reading Vernier scale markings. To use, lower bracket is set at starting point on workpiece being inspected, desired height to be checked is determined by placing corresponding gage block on lapped platform and lowering dial indicator bracket until needle comes in contact with gage block surface. Indicator is set at "0" with fine adjustment." The gage block is then removed and lower bracket moved upwards, until platform comes in contact with dial indicator needle and adjustment to "0" again


"THE F & H NEW TIME SAVING WAY"
"THE OLD WAY"
2–BRACKET LOWERED TO CONTACT GAGE. ADJUSTMENT TO ZERO
3–GAGE BLOCK REMOVED LOWER BRACKET RAISED TO INDICATOR. ADJUSTMENT TO ZERO
1–CORRESPONDING GAGE BLOCK PLACED ON PLATFORM
SECOND REQUIRED HEIGHT INSTEAD OF BUILDING ON FIRST COMBINATION
FIRST STEP
FIRST GAGE BLOCK COMBINATION

made. Contact point of test indicator is then at the desired height for checking workpiece. For laying out work, remove test indicator and replace with scriber. Required heights determined by using gage blocks set on platform; "0" setting of dial indicator with needle in contact with surface of blocks; removal of blocks; raising of platform to contact dial indicator needle and resetting of same to "0". Scriber point is then at proper height for marking workpiece. *Specifications:* Column length 14"; Column extensions, (2) 10"; Maximum vertical capacity 30"; Dial indicator graduated .0001"; Test indicator graduated 0.001"; Weight 15 lbs.; Fine adjustment range [illegible].—*F and H Mfg. Co., 10338 Gratiot Ave., Detroit 13, Mich.*

Geiger-Muller Tubes

New Geiger-Muller tubes are of extremely high sensitivity, detect extremely minute traces of x-radiation and similar emanations. Formation of a single ion pair anywhere within active volume of tube releases a flow of current which can be translated into an instrument reading. Simplest form of Geiger-Muller tube consists of a central wire electrode and a concentric cylindrical metallic electrode separated by an atmosphere of noble gas such as argon and often containing an organic quenching additive such as alcohol to terminate the pulse once the "triggering" pulse of radiation has ceased. The type of tube shown is now used in maker's Geiger-Muller x-ray Spectrometer for qualitative and quantitative analysis of crystalline and certain amorphous materials.—*North American Philips Co., Inc., 100 E. 42nd St., New York 17, N. Y.*



Multi-scale Monocular

New Multi-Scale Monocular is said to be a unique optical instrument, the outstanding feature of which is that it provides the means to measure and compare small objects with the aid of a highly-corrected six-power optical system and six selectable scales, all of which are incorporated in the instrument. Optical arrangement projects selected scale in plane of object to be ob-

D.P.I. Vacuum Coating Units

MEETING today's rigid requirements of uniform, versatile, high-capacity production.

The units pictured here are part of a large battery of the new D.P.I. Vacuum Coaters—Model LC 1-500-3, designed to deposit metals or metallic salts on glass, other metals, and plastics.

SIX OUTSTANDING FEATURES

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2. Convenient high-vacuum valve
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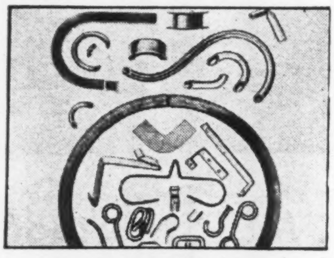
"Die-Less Duplicating" Eliminates Time Loss and Die Expense!

The DI-ACRO Bender is a precision unit, designed to form and duplicate an unlimited variety of parts and pieces—eliminating, in many cases, the need for special dies. Tubing can be accurately formed with the DI-ACRO Bender to a center line radius as small as 2½ times the outside diameter of the tube without distortion. Shapes and outlines, impossible to obtain with regular production dies, are easily formed with the DI-ACRO Bender. These include round, half-round, hexagon, and square rod, tubing, angle, channel, moulding, strip, stock and bus bar.

Stops may be set and material guides mounted for production work in excess of 1000 operations per hour. The Bender is compact and portable, ideal for temporary or permanent work. There are no extra parts to purchase, as the DI-ACRO Bender has been built to cover a wide working range, with simple conversions.

Peacetime production for industry, forecasts the return of Wrigley's Spearmint Gum—that favorite "help on the job," for workers everywhere. But Wrigley's Spearmint will be back only when conditions permit its manufacture in quality and quantity to meet your needs. Until that day, we ask you to remember the famous Wrigley's Spearmint Wrapper shown at right, as your guarantee of the finest chewing gum that can be made.

You can get complete information from
O'Neil-Irwin Manufacturing Co., Minneapolis 15, Minn.



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served, without scale itself being in contact with surface under observation, making the Monocular especially desirable in examination of abrasive surfaces. Scale desired for a particular measurement can be brought into field of view by simply turning the outer rim of eye cap. Circular field of view, of 1″ diam., is automatically in focus when instrument stands on its base; scales appear in field of view as brightly-illuminated markings superposed upon viewed surface. Dimensions: height 2½″; diameter 2¼″; weight 7 oz. Small size and light weight make instrument suitable for a wide variety of uses, such as examination and inspection of textiles, finishes, surfaces and textures. Since instrument provides means for comparison as well as measurement, it finds applications in plants where inspection measuring or comparison should be done under magnification.—*Ray Control Co., 975 East Green St., Pasadena 1, Calif.*

Inertia Type Linear Vibrometer

New "Linear Translator" for linear vibration studies permits vibrations to be mechanically detected, amplified and recorded on maker's "Type 4" Vibration Recorder.

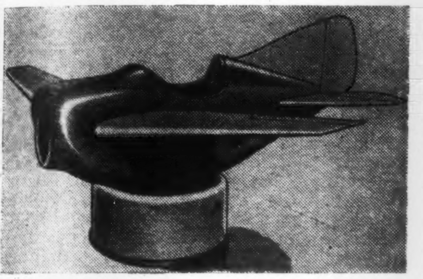
Unit consists of a cylindrical inertia mass guided at both ends by anti-friction bearings mounted in a surrounding shell attached to an angularly-graduated disk and quill. This quill fits into the opening of the recorder housing. The inertia mass is mechanically cushioned so that the vibrations are isolated; relative motion of recorder and inertia mass is transmitted through a bell crank to the recording stylus. New translator may be rotated to respond to vibrations in any selected direction at right angles to quill axis. Magnification ratio expresses relation between displacement of stylus to relative motion of recorder to inertia mass. Range of operation: Frequency, 250 to 10,000 vpm. Displacement, 0.25″ maximum double amplitude. Diameter, 6″; overall length, 5¾″, weight 17 lbs. — *Commercial Research Laboratories, Inc., 20 Bartlett Ave., Detroit 3, Mich.*

Crystal and Holder Assembly

New "MX-9" is a high-quality Brazilian quartz crystal mounted in a dust- and moisture-proof holder designed to fit a standard three-prong crystal socket. It is designed for frequency control in communication and experimental service (frequency to be specified by customer). All units are calibrated against a primary frequency standard which maintains an accuracy of one part in five million. *Frequency Range:* [illegible] to 10,000 kilocycles. *Frequency Accuracy:* A tolerance of 0.01% of the specified frequency at 20°C. is maintained for all frequencies between 250 and 1200 kc. Between 1200 and 10,000 kc., this tolerance is 0.02% of the specified frequency. *Temperature Range:* "MX-9" crystals will operate satisfactorily at any air temperature between —40 and +55°C. Nowhere in this range will output drop below 0.83 ma. For frequencies between [illegible] and 1200 kc., frequency variation will never be more than 0.025% of specified frequency, and for frequencies between 1200 and 10,000 kc. this tolerance is 0.015% of specified frequency. On "MX-9" models with higher temperature coefficients a thermostatically controlled heater is incorporated in the case so that all "MX-9" crystals will fall within the above tolerances. *Multiple Frequency:* "MX-9" crystals will not respond to any but the specified frequency. *Dual Crystal Holder:* A model is available containing two crystals in the same holder. It also mounts into a standard three-hole crystal socket. *Trimmer:* For applications where extremely close frequency tolerance is a requirement, single-crystal holders can be supplied with a shunt capacitance trimmer mounted inside holder but with an external trimming adjustment. *Electrodes:* "MX-9" crystal holders for use on frequencies below 1200 kc. are equipped with fixed air gap electrodes. Those above 1200 kc. use clamp type electrodes.—*Bendix Radio, Baltimore, Md.*

Elementary Link Trainer

New Elementary Link Trainer, designed for classroom use and pre-flight instruction, is a hoodless, streamlined trainer which can be incorporated into the aviation programs of schools and colleges. As a classroom demonstrational device, Trainer can be used to illustrate principles of aerodynamics, navigation and radio as well as enable a student to learn about airplane controls, flight patters, etc. Laymen who "want to learn to fly" will find it valuable in pre-flight training before taking to the air. Accessories for advanced ground instruction may be added when desired. *Link Aviation Devices Inc., Binghamton, N. Y.*



Advanced Link Trainer

New advanced Link Instrument Flying Trainer which, according to pilots, "flies more like an airplane than an airplane does," is said to be the outgrowth of nearly 20 years' experience in the synthetic training field. It contains a new air-loaded control system, trim tab controls, engine instruments and their controls and built-in longitudinal, lateral and directional stability. Those who have operated it report that the new model handles much like an Army AT-6 or Navy SNJ. An experienced pilot stepping into the cockpit of this new trainer with his eyes closed would feel right at

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All meters are fully shielded, permitting use on either magnetic or non-magnetic panels. Operation is accurate and dependable even up to 85° centigrade. Internal pivot construction in D.C. types assures longer life and greater resistance to shock and vibration. Write for further information today.

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WEAR RESISTANT
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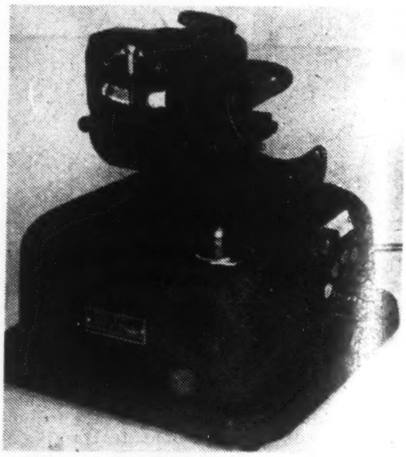
home when he opened them. Practically all of the controls, knobs, levers, switches and handles to which he is accustomed are there. The instrument panel—modern in appearance — contains twenty-one familiar faces and even the vibration and noise of an airplane is present. Numerous new features have been incorporated in this model. Power effect on longitudinal stability has been added, and a complete change in design of the airspeed system now makes it possible for pilots to practice climbs and descents exactly as they do in a modern airplane. Likewise, a propeller pitch control not only changes the tachometer indication but has the correct effect on the whole trainer. Cylinder head temperature indicator with cowl-flap control, oil temperature indicator with oil-cooler shutter control, carburetor air temperature indicator with carburetor-heater control, oil pressure and fuel pressure gages have been included. The engine instruments are affected by power setting, altitude and "outside air temperature" and are controlled in the same way as similar instruments are controlled in an airplane. Flaps and undercarriage are available for low approaches and, when they are lowered, power and attitude must be handled accordingly. Aural null and/or automatic direction finding practice is made possible by the inclusion of a new unit and any desired instrument-landing system using a glide path and localizer beam is available. Other optional equipment includes a unit which will record all conversation between student and instructor. This device affords the student a chance to hear his own mistakes, correct his voice technique and learn proper handling of microphone and radio telephone procedures. The records also provide a chief instructor with a check not only on the students but on the instructor as well.—*Link Aviation Devices, Inc., Binghamton, N. Y.*

Stroboscopic Light Source

New cold-cathode electron tubes with two internal trigger grids for operation in simple capacitor-discharge circuits are announced. Used as a source of stroboscopic light, these strobotron tubes provide pulse frequencies up to 240 pps. Applications include continuous visual inspection of moving textiles and printing from high-speed rotary presses; precise timing of cams, shafts, flywheels, gears, spindles and shuttles and many other rotating or reciprocating parts. Strobotrons also make visual study of stress or effect during operation in actual service easy by creating "stop", reverse or slow motion which may be photographed for permanent record. Frequency of flashing may be readily controlled and calibrated to produce a compact direct-reading instrument. High available peak currents make these tubes particularly adaptable to relay and control applications. Fully enclosed and without moving parts they provide positive and powerful relay action in many applications where other types of relays may produce operating hazards in corrosive or explosive atmospheres. Standard strobotrons measure 4$\frac{9}{32}$″ overall including T-9 bulb and a 4-pin base, 1$\frac{3}{16}$″ in diameter. 50-milliamperes average current with 350-volts d.c. on the anode permit instantaneous surges of 5 amperes. Grids are operated at 70 volts d.c. and 15 ma. maximum. There is a drop of 75 volts during glow discharge and a 20-volt drop during arc discharge. Starting is initiated by discharge between any two elements but usually between grids or either grid and cathode. Starting voltages range between 70 and 145 d.c., depending on the elements used and their polarity.—*Sylvania Electric Products Inc., Salem, Mass.*

Tester for Turn-and-bank Indicators

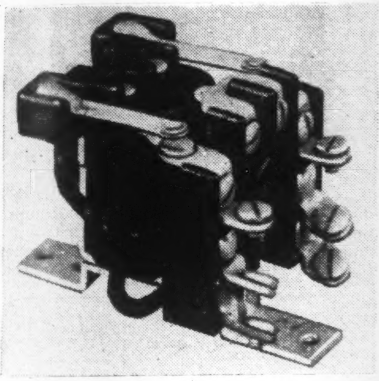
New "Model 1242" turn-and-bank indicator tester has been developed to meet U.S. Navy requirements. It is a four-speed tester having rates of 90, 180, 360, and 1080 degrees per minute, obtained by synchronous motor and all-gear drive. Test rate is quickly changed, while tester is either running or stopped, by means of dial type knob on right side (see illustration). Three-position switch permits making tests in either direction and at any rate. Hollow spindle passage for air-driven instruments obviates need of



dragging heavy hoses around with the carriage. A friction clutch incorporated into drive to vertical spindle provides a safety feature in case the carriage should be jammed. This clutch also provides for easily testing the friction, centralization and damping of the Turn Indicator by moving the carriage back and forth by hand. Variations of this basic design are available to provide a single-rate Tester of 180 degrees per minute, or other special rates. Tester is equipped with either of two styles of carriages: A carriage for two Turn Indicators with spring-loaded fingers to hold the instrument by its mounting flange; a carriage which mounts the instruments to a panel with thumb screws (see illustration). Extra carriages to hold four or six instruments at one time can be furnished.—*Ideal Laboratory Tool & Supply Co., P. O. Box 198, Cheyenne, Wyoming.*

A-c. and D-c. Magnetic Relays

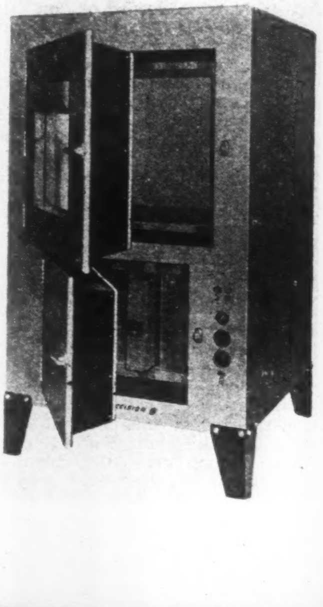
New single- and two-pole a-c. and d-c. magnetic relays for industrial and electronic applications are announced. Ratings: 10 amperes at 24 volts d-c. and 110 volts a-c.



5 amperes at 220 volts a-c.; 1 h.p. single-phase 110 and 220 volts a-c. Contact arrangement: s-p. and d-p.; normally-open, normally-closed, and double-throw. Silver-to-silver contacts. Armatures are self-aligning. All wiring terminals (either screw or solder) are easily accessible from the front. Single- and two-pole a-c. and d-c. relays have identical bases for complete interchangeability in mounting. Relays may be mounted either from front or rear. All are available in open type or with sheet steel general-purpose enclosure. — *R-B-M Mfg. Co., Logansport, Indiana.*

Cold Cabinet

New "Vari-Temp Cold Cabinet," available in 1 ft.^{3} and 8 ft.^{3} capacities, operates with dry ice and was developed to satisfy all the cold tests requirements of present-day test-



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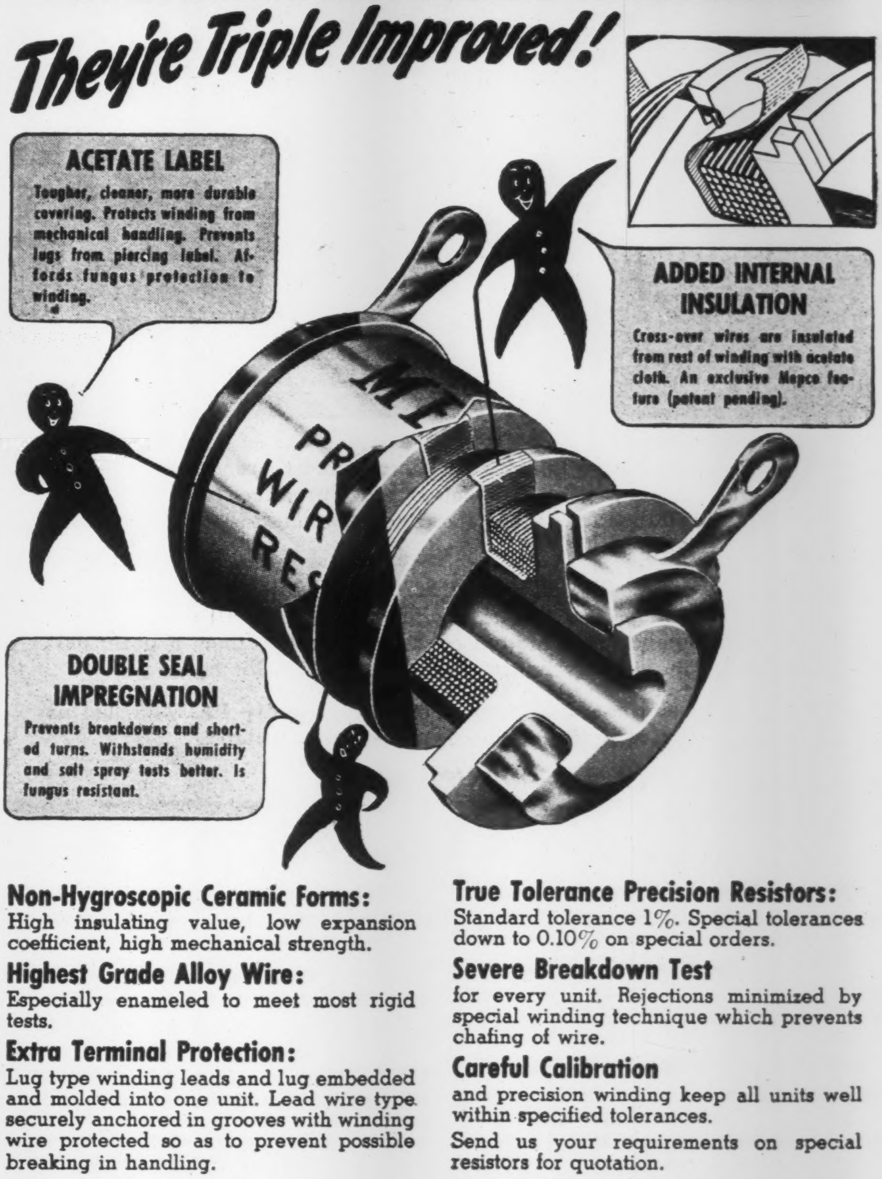
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Tougher, cleaner, more durable covering. Protects winding from mechanical handling. Prevents lugs from piercing label. Affords fungus protection to winding.
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Cross-over wires are insulated from rest of winding with acetate cloth. An exclusive Mepco feature (patent pending).
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Prevents breakdowns and shorted turns. Withstands humidity and salt spray tests better. Is fungus resistant.
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High insulating value, low expansion coefficient, high mechanical strength.

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Lug type winding leads and lug embedded and molded into one unit. Lead wire type securely anchored in grooves with winding wire protected so as to prevent possible breaking in handling.

True Tolerance Precision Resistors:
Standard tolerance 1%. Special tolerances down to 0.10% on special orders.

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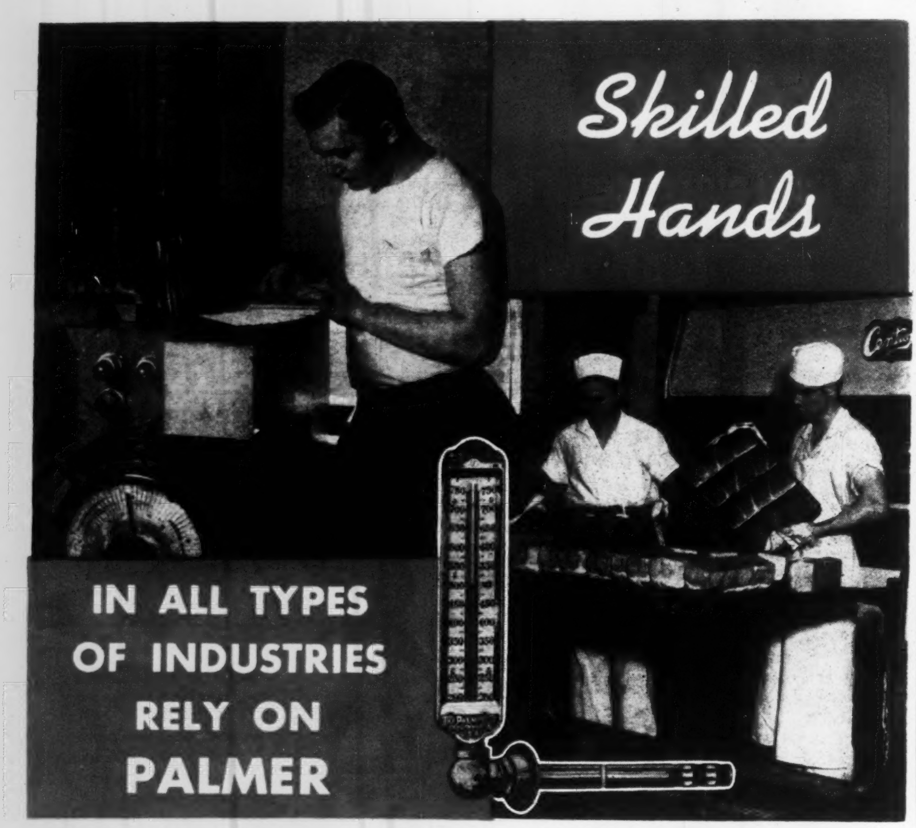
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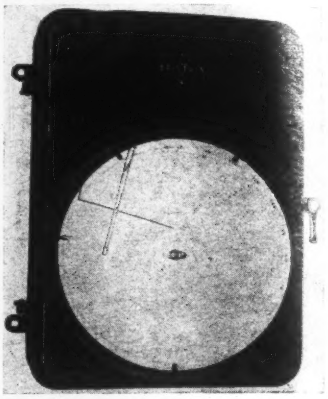
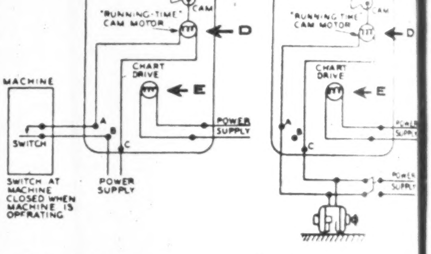
ing techniques, from −90°F. to +220°F. Chamber is sufficiently large to hold the various pieces of apparatus used in making the Young's Modulus test of natural and synthetic elastometers at normal and subnormal temperatures according to ASTM D-797. Apparatus and specimens under test are readily visible at all times since a seven pane sealed window unit prevents condensation and frosting. Ready visibility is insured by a fluorescent light which is shielded to prevent both direct and indirect glare. Thermometers and instruments in any part of the chamber can be easily read from the outside, since there is no glare and no condensation. Incorporation of a heating unit in this cold chamber allows a full temperature testing range from −90°F. to +220°F. Thermal losses are minimized by completely insulating inner wall from outer wall. An air stirrer, which holds temperature in specimen chamber constant to ±1°F., is automatically turned off when door is opened, to prevent a rapid temperature change. A blower circulates the air to and from the chamber. Heavy gage tinned copper has been used in all parts liable to corrosion due to condensation. To facilitate cleaning and provide for disposal of condensation on inside of chamber, drains are provided for both dry ice chamber and test chamber. Time required to reach various temperatures starting at ambient temperature of 75°F.: +32°F., ¼ hr.; 0°F., ½ hr.; −25°F., 1 hr.; −50°F., 2½ hrs.; −75°F., 4½ hrs. Cabinet is of extremely rugged construction, to give years of service. Special construction and arrangement of ducts prevent carbon dioxide gas from entering specimen test chamber. All temperatures are controlled thermostatically, one thermostat being provided for low temperatures, and one for high temperatures. The 1 ft.^{3} box is 53″ high, 26″ wide, 26″ deep; capacity of dry ice trays is 15 lbs. The 8 ft.^{3} box is 73″ high, 39″ wide, 39″ deep. Door of test chamber, which is 24″ × 24″ is located at a convenient operating height of 48″. When the 24″ × 24″ door is open the entire test chamber is completely accessible. Electrical characteristics: [illegible] volts, 60 cycles a.c.—*Precision Scientific Co., 1750 N. Springfield Ave., Chicago 47, Illinois.*

Running-time Recorder

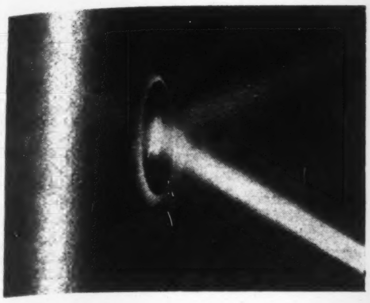
New Running-time Recorder records on a circular chart the "on" and "off" [illegible] of production machinery, pumps, presses, motors, conveyors, etc., in hours, minutes, and seconds for a given period, as well as the time-of-day at which each occurred. Running-Time Recorders are equipped with two synchronous motors as shown in the drawings at *D* and *E*. Motor *D*, energized when machine whose performance is being checked is operating, drives pen-arm across chart on a timed basis to record duration of running time on the running-time scale. When pen reaches end of scale it drops back to zero and is again driven across the chart, this process being repeated as long as machine is operating. Synchronous motor *E* rotates the recording chart counter-clockwise in the standard manner so that elapsed time is recorded on the scale concentric with chart center. When machine under study is stopped, motor *D* is de-energized and recorder pen draws a record of "off" time on the elapsed time scale, showing when machine was shut down and length of shutdown period. Switches or circuits controlling the synchronous motor driving the pen arm may be operated mechanically, pneumatically, or hydraulically. Motor circuits may be used. Photocells, thermostats, or any device that will close a circuit may also be used.—*The Bristol Company, Waterbury 91, Conn.*





Beam-splitting Pellicles

New optical pellicles for use as beam-splitters, now available in large-quantity production, are very tough membranes, about 0.0005″ thick, transparent as glass, and with surfaces optically flat to within a few wave-lengths of light. They are mounted over open frames. They have found wide application in war equipment where superposition of various optical figures is necessary. Their shatter-proof properties have made them especially advantageous in such applications. They are used in tele-



scopes and other viewing instruments where two phenomena are to be observed simultaneously or when an illuminated scale is to be superposed on the object under inspection. They are also used in one-shot color cameras to fractionate the light into three beams, thus providing for the simultaneous exposure of three different color-separation negatives. Pellicle mirrors may be supplied for any reflectance between 8% and 50% at the desired reflection-transmission ratio. There is appreciable absorption at the higher reflectances with the standard coating. A special "NO LOSS" coating is available which is substantially free from absorption losses even at the higher reflectances. Several available types of pellicles, different in chemical composition, vary in organic solubility and in elasticity, and in some degree in their optical properties. Dyes may be incorporated into the pellicles to transmit selected colors only. Pellicles may be mounted on almost any shape frame. Pellicle beam-splitters have a number of advantages over glass beam-splitters. Ghost images do not appear, for, owing to the thinness of the pellicle, the "ghost" coincides with the image. Refractive errors are eliminated in pellicles because the displacement of rays passing through them is negligible. With glass mirrors refractive distortions are unavoidable and are frequently serious. —*National Photocolor Corp., 305 East 43 St., New York 17, N. Y.*

Electric Soldering Irons for Battery Use

New soldering irons were developed for operation off the batteries of trucks and planes, are now available in 100- or 200-watt sizes, wound for either 12 or 24 volts, with either 6-foot or 12-foot cords, and with conventional plug cap or battery clips. All "Hexacon" irons so equipped have also such features as damage-proof hexagon-shaped barrels (protect element from mechanical injury) and scale-resistant element cores (prolong element lift).—*Hexacon Electric Co., 179 W. Clay Avenue, Roselle Park, N. J.*

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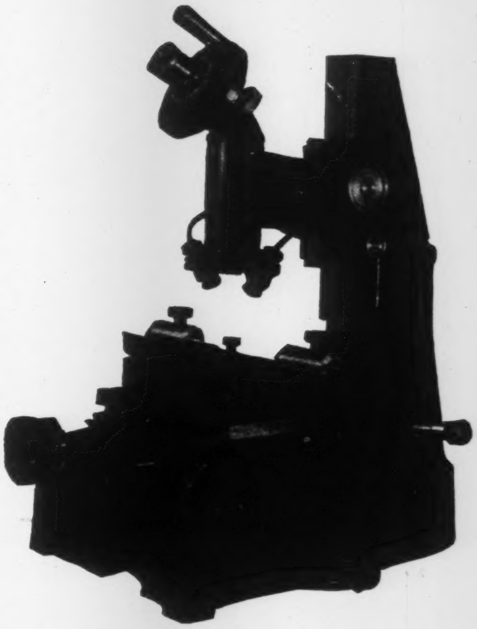
New "Autoflight Controlled Action" Bellows are said to represent a new approach in bellows fabrication where the utmost precision of bellows action is required. Mechan-



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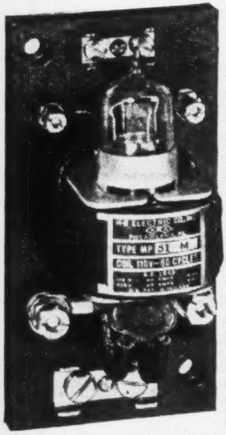

However, mercury-plunger relays by H-B Instrument are *not* limited to tube applications but may be used for practically any timing, load or control circuit. They are available for a-c up to 440 volts and for d-c up to 250 volts, with contact capacities as high as 30 amperes. All have hermetically sealed mercury-to-mercury contacts which are positive, chatterless and noiseless, with no exposed arc. Unique crown-shaped wire guide holds plunger straight and friction-free. A faster, cleaner break results. Service life is prolonged. Get quotation on your requirements.

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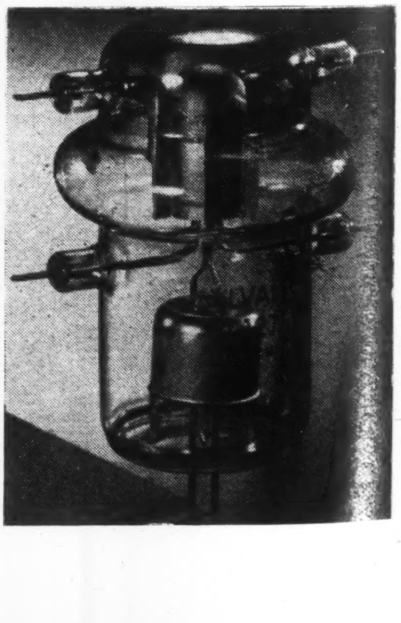
ical characteristics are derived from the closely held convolutions from which the bellows are assembled. These convolutions are so designed that the elastic limit of the material is never exceeded within the working range of the particular bellows. By reason of method of fabrication (said to be exclusive) deformation of bellows material is minimal and hysteresis of this type of bellows is negligible. Limited cold working done on bellows diaphragm assures constant properties and homogeneity of material. Mechanical integrity of the device is assured by sealing rings in the inner and outer periphery, which are sealed by silver solder or other suitable means. Because bellows movement occurs in corrugated diaphragm and none in sealing rings, bellows is gas- and liquid-tight. Riveted-over feature of sealing rings assures utmost mechanical strength in this type of construction. As stresses in diaphragms are well below the elastic limit, new bellows are fatigue-resistant, predictable in performance, unchanging in quality and characteristics. Engineered to customer specifications, new bellows are made from stainless steel, phosphor bronze, beryllium copper, brass, or special alloys. Units range from custom-made closely-held bellows satisfying the most exacting control requirements, to mass-produced low-cost bellows of standard characteristics. New bellows "have the highest ratio of displacement and volume change of any type of bellows construction." Manufacturer is in a position to offer quick delivery and service on production runs of standard bellows, and in addition is a ready source for speedy delivery of experimental and small lot bellows purchases. Complete control units, such as pressure switches incorporating "Autoflight" bellows, can also be had on short notice.—*G. M. Giannini & Co., Inc., 161 East California St., Pasadena 5, Calif.*

Lamps for High-frequency Power-measurement Circuits

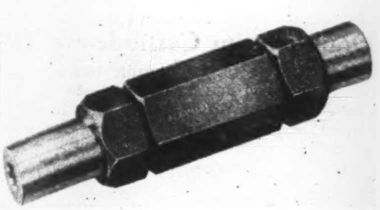
New "Power Measurement Lamps," available in six types, provide simple, direct measurement of the power output of electronic and radio communication equipments at frequencies up to 900 Mc. and in ranges between 0.05 and 25 watts with accuracies within 5% or better, depending on the type of reading taken. Essential feature is a pair of small filaments—both alike in every significant characteristic. Power output measurements are made by connecting one filament to the high-frequency output and the other to an a-c. or d-c. source. Voltage of the second filament is regulated until both filaments are equally bright. Power is determined by instrument readings in the a-c. or d-c. circuit with equal power dissipated by the filament in the high-frequency circuit. Increased accuracy may be obtained by reversing the filament circuits and aver-



aging results. Calibration, providing increased accuracy independent of filament differences, may be obtained by applying voltage or measuring the current of one filament and then applying voltage to the other until the two filament brightnesses are equal. Power dissipated by the second filament is then calculated in terms of voltage or current in the first filament. Useful range may be extended when a dark glass filter is used for visual filament comparison or photocell measuring equipment is used. Filament characteristics assure constant temperature and color for dissipation of a given amount of d.c. or high-frequency a-c. power. *—Sylvania Electric Products Inc., Emporium, Pa.*

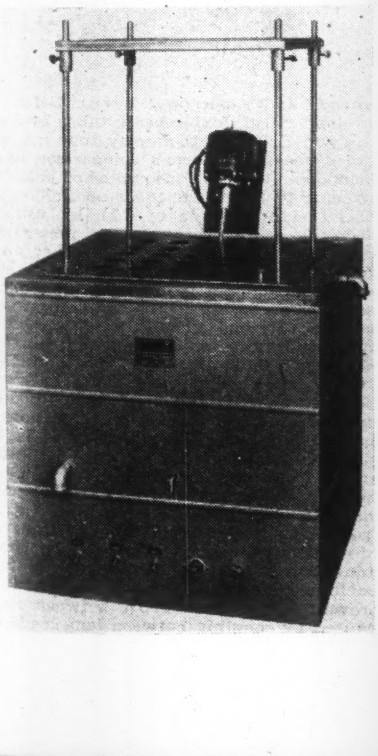
Reversible-insert Plug Gages

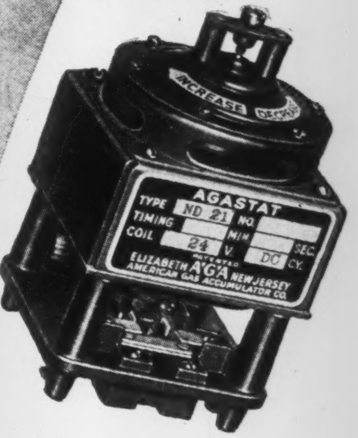
New "Dubl Duty Cylindrical Plug Gage" has a light aluminum alloy collet type handle which firmly positions a set of wire type cylindrical plug members. This unique type of handle enables user to reverse gage member after it has worn under allowable limit and take full advantage of unused gaging surface that was formerly in handle. This feature increases gaging life and lowers cost per hole gaged. There are no tapers, no drift pins and no split handles. Members are made of high-grade tool steel, hardened, ground, plated and lapped, furnished out of stock in a size range of 1/16" to 1" in increments of 1/16", made to commercial Y tolerance and limits are established at ±0.0005 from the basic figure. — *Schrillo Aero Tool Engineering Co., 8715 Melrose Ave., Los Angeles 46, Calif.*



Aging Bath

New aging bath is an oil-immersion type for aging rubber and other elastomers in oils or liquids in test tubes, according to ASTM D-471 and D-735 tests of comparative ability to withstand effect of immersion in oils and liquids. It may be used to secure comparative data on which to base judgment as to service quality; is especially





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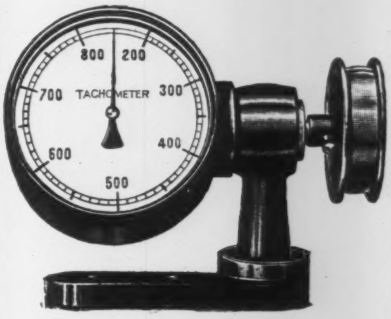

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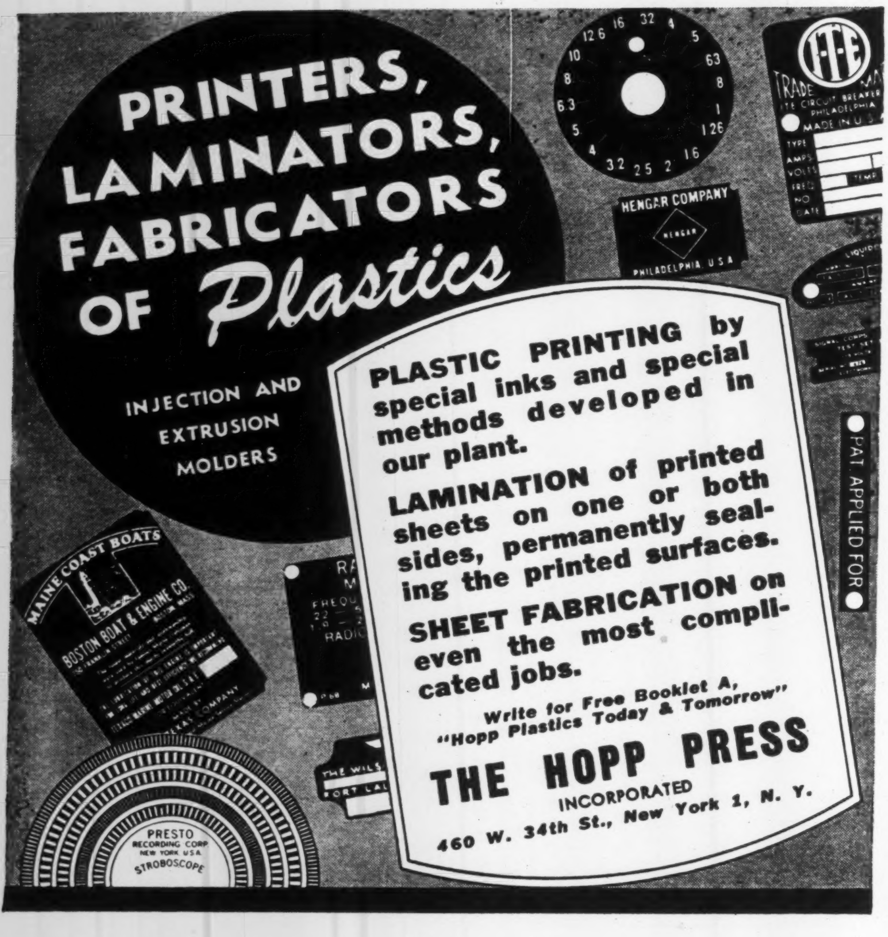

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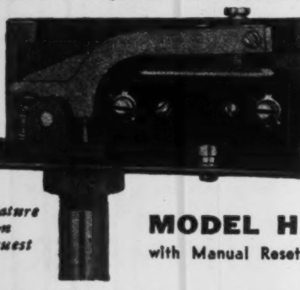

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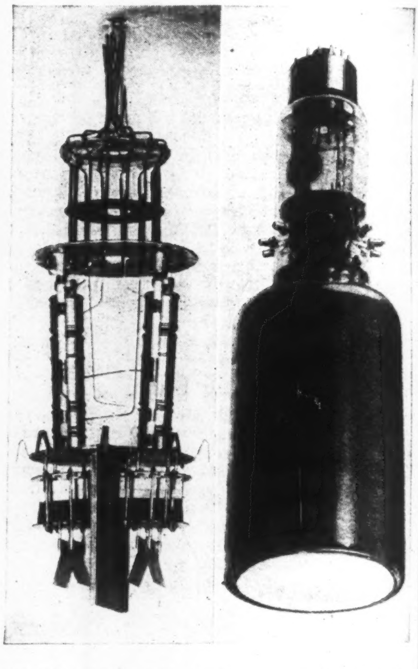
useful in research and development work. Capacity of aging bath, 24 test tubes 38 mm. dia. × 200 or 300 mm. long. Test tube rack is adjustable, can be readily removed, is made of stainless steel and rests directly in the bath. Top shelf of rack holds the condenser in a vertical position. Temperature of bath is 35 to 200°C. thermostatically held to ±1°C. Ball-bearing fully enclosed resilient-mounted motor stirrer provides complete circulation. Interior of bath is made of stainless steel, exterior of "galvannealed" iron finished in high-temperature aluminum. 3" of glass wool insulation is provided on sides and bottom. Overall dimensions, including rack: 49" high, 24" wide, [illegible] deep. Oil capacity, 19 gals. 24" support stand for bath, with upper and lower shelf, can be furnished. Electrical characteristics: 115-volts 60-cycle a-c., 3000 watts. This bath can also be used for aging rubber and other elastomers in air in test tubes. Condenser tube rack and test tube holders can be easily removed making it a general-utility bath. —*Precision Scientific Co., 1750 N. Springfield Ave., Chicago 47, Ill.*

Double-beam Cathode-ray Tube

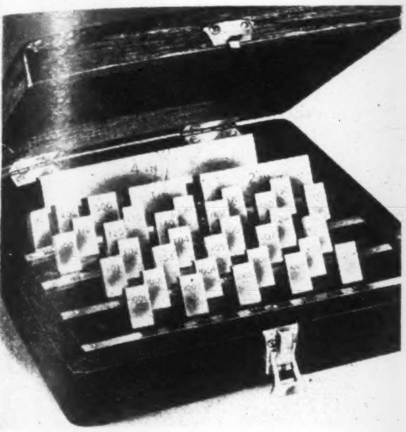
New "Type 5SP" double-beam cathode-ray tube provides two complete "guns" in a single glass envelope, both aimed at or converging on the single 5" screen for simultaneous and superposed traces. Before the development of double-beam tubes by American and British cathode-ray tube manufacturers, the simultaneous comparison of two phenomena could be accomplished either (1) by using two separate tubes or oscillographs placed side by side or (2) by using an electronic switch in order to present first one phenomena and then the other on the same tube screen in rapid succession. Method 1 was obviously unwieldy and did not permit superposing traces for accurate comparison; Method 2 had limitations caused by frequency response and switching rate of the electronic switch, as well as inability to use independent time bases or sweeps. New "Type 5SP" double-beam cathode-ray tube not only removes these limitations, but has advantageous features: there is complete and independent control of the X, Y and *Z* axis functions for each beam. Adequate shielding between "guns" and "plates" minimizes "cross-talk" particularly at high frequencies. Deflection plate leads are brought out through the glass envelope wall, minimizing shunt-input deflection-plate capacitance and lead inductance, and also preventing interaction between signals caused by coupling between long leads. Sec-



ond-anode leads are also brought out through the envelope wall in order to provide better insulation and longer leakage paths. Standard Army-Navy diheptal 12-pin base fits the standard socket. Electrode voltage ratings are similar to those of the Army-Navy preferred Type 5CP1. Contact connectors for electrode leads are supplied with the tube.—*Allen B. DuMont Laboratories, Inc., 2 Main Ave., Passaic, N. J.*

Tungsten Carbide Gage Blocks

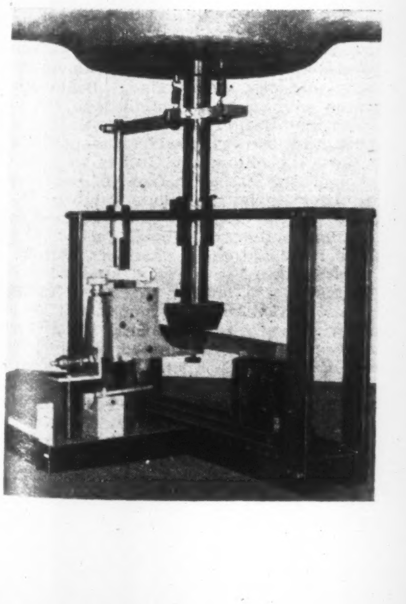
New tungsten carbide gage blocks are said to represent "the first time a complete set of gage blocks meeting Bureau of Standards requirements has been manufactured



from tungsten carbide and offered for general use." New Gage Blocks are manufactured in sets of 35 pieces ranging in size from 0.001" to 4.000". They are said to have a wear resistance at least 100 times greater than that of steel gage blocks, or 98 times greater than chrome-plated. By reason of "Fonda Ultra-Finish," 0.2 to 0.4 micro-inch r.m.s., wringing qualities of Fonda Carbide Gage Blocks are said to be far superior to those of either steel or chrome gage blocks. Carbide blocks are corrosion-proof against moisture or fingermarks.—*Fonda Gage Co., 53 Daly St., Stamford, Conn.*

Combination Deflectometer and Flexure Tool

New combination flexure tool and deflectometer, for testing molded plastics, plastic laminates and woods, will make tests in bending in accordance with latest federal and ASTM specifications and will fit any testing machine. Deflectometer measures the deflection from center of specimen and conveys this to an autographic stress-strain recorder which gives the load-deflection curve. Operator can adjust magnification of deflection in multiples of 5, 10, 20, 50, 100



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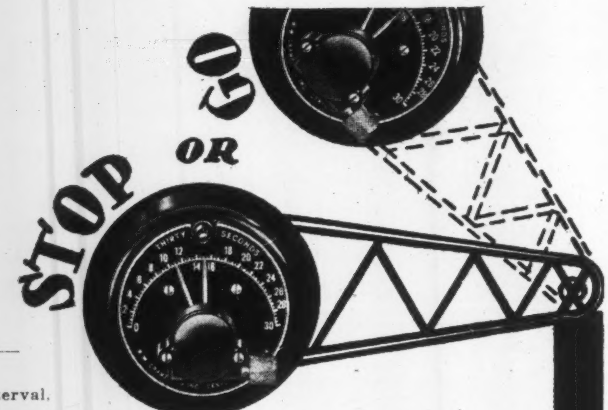

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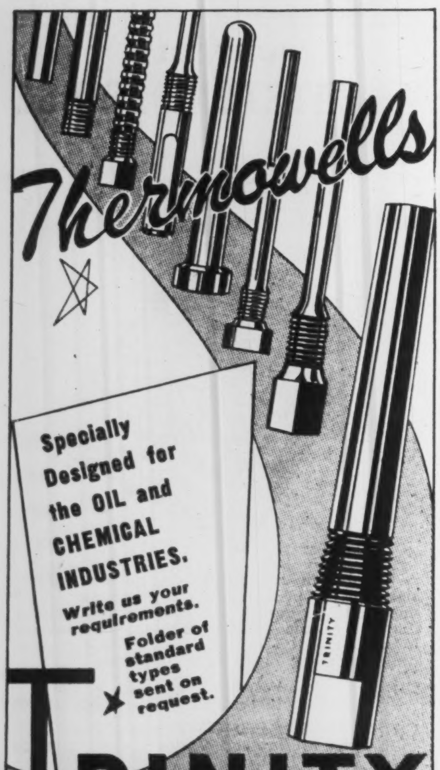

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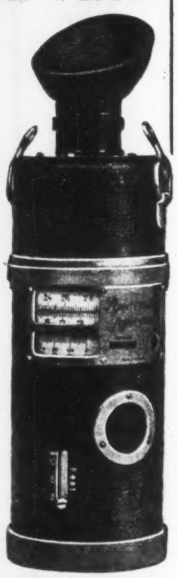

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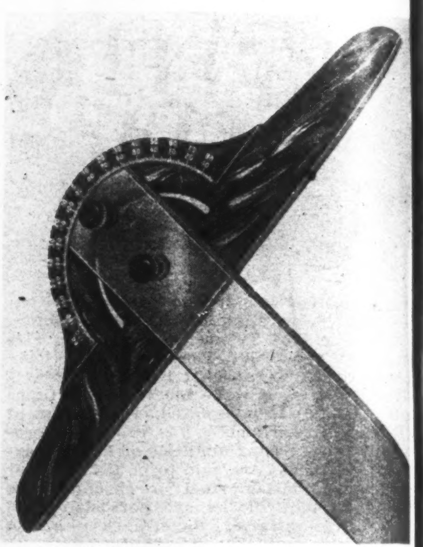
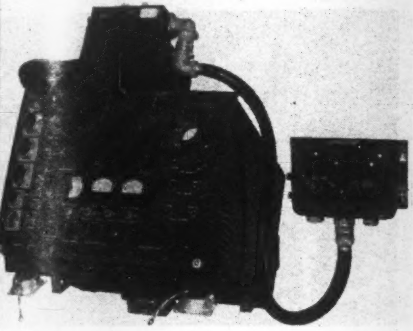
Plastic T-square

New all-plastic streamlined adjustable T-square is molded of heavy colorful plastic with a protractor feature graduated in degrees. Arm allows clear visibility over entire surface and is so fastened to the head as to allow it to pivot to any angle. Arm is also equipped with brass lugs to permit ink ruling. Another feature is interchangeable arms, available in 12", 18", 24" and 30" lengths.—*C-Thru Ruler Co., Hartford, Conn.*



Radar Camera with Industrial-use Features

New camera equipment of advanced design for use in photographing radar images can be used with every type of airborne and shipboard radar and is expected to be adapted for use with all ground types. Despite end of war, it is being produced for Army and Navy. Known as the "Automatic Radar Recording Camera," it consists of five units: camera, magazine, beamsplitter, adapter casting and control box. Complete camera installation is tied in with the radar circuit and camera itself is mounted atop the radar's oscilloscope. Unit is so arranged that operator sitting in front of radar scope can observe the luminous picture of the terrain, while camera simultaneously photographs it for continuous record. Operation is fully automatic: camera can be set at beginning of a mission and need only be adjusted if a change in rate of exposure is desired. Commercially, unit will be used mainly as recording camera. Radar-record photography can be applied to give radar maps of worldwide airline routes, as an aid in determining safe navigational paths, as a supplement to training of radar operators. Further, camera and magazine proper can be used with various adaptations for installation in a plane to photograph performance of a group of instruments in flight. Additionally, it can be used on board ships or in industrial plants to provide an irrefutable record of the performance of some object or instrument. In laboratories, new camera can photograph minute phenomena illustrated on oscillographs and other instruments, eliminating dependence on visual examination alone. New camera has several novel design features. One is its beam-splitter, contained in viewing hood, which allows operator to view radar reflection in normal manner while image on radar screen is reflected into camera; beam-splitter glass reflects the scope image, passing yellow light to the eye, and reflecting only the more actinic blue light upward for photographing. Shutter opens at beginning of radar impulse, then closes while film is being moved from one exposure to the next. Camera re-cycles itself at end of impulse. Shutter, of rotary type, is unusual in that it is normally-open and, upon operation of the trigger mechanism, closes for specified interval. Its specified speed is 1/40th second. When it is desired to conserve film, selector switch and stepping relay command camera to take one picture every scan, one every other scan, 3 out of 12, or 5 out of 60. To aid photographer in keeping a tabulation of all data bearing on the pictures he is taking, camera has an elaborate recording chamber which makes it possible to record on each frame of film such factors as time and aerial number of exposure, range settings, variables such as altitude, scale, etc. Recording chamber carries a watch, data card, and six small indicator lights which, by their position on the film, may show any desired variable. Camera's interchangeable magazine unit (the only part of the unit that engages the photographer's attention while the camera is clicking) holds 100 feet of 35-mm. motion-picture film, can be changed quickly, and its face has a detachable cover to protect it from excessive dust and light when it is being transported. Unit can operate at all altitudes to 35,000 feet, as well as at "all extremes of temperature." This feature is essential not only for aircraft use but for laboratory use in testing new instruments.—*Fairchild Camera & Instrument Corp., 475 Tenth Ave., New York, 18, N. Y.*



Fairchild Navy-Army type radar camera installed on MT-132/AP S-2 radar set. Illustration being reduced to our column width from 8" × 10" photo, white-letter markings do not show. Some of them are as follows: Under the three electrical indicating instruments (left to right) "Tilt Indicator, Crystal Current, Trans. Current." Immediately under are four toggle switches for "Tilt, Beacon, Crystal Current, Trans. Current." At upper right is "A" Scope Centering viewer, with control knobs for Horiz., Vert., Focus, Brilliance. On separate unit at right, main knob is for frequency of exposures, from "Every Scan" to "5 Every 60 Scans."

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Electron Tubes?

See page 715

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● This unit, generating its own frequency or synchronized from an external source, will be found invaluable in many fields. FM, AM and Television Broadcasting—Telephone and Telegraph Communications—Manufacture of Transmitting and Receiving Equipment and Parts.

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General Electric Company,
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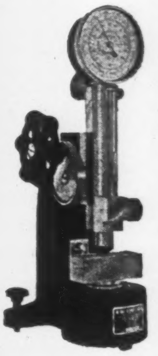

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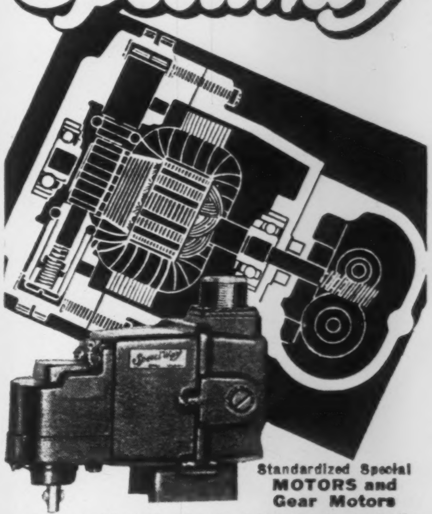

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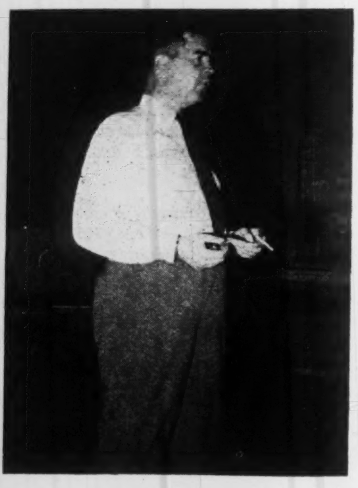
Instrument Societies

CHARLESTON, W. VA.

"Measurements Unlimited" was the subject of an address by Everett S. Lee, Engineer, General Engineering and Consulting Laboratory, General Electric Company, at the September 10th meeting of the Charleston Instrument Society, held at the Ruffner Hotel.

Mr. Lee, illustrating his talk with slides, told of many interesting instruments developed by G.E. Among those he described were the photoelectric recorder, circuit analyzers, thickness gages, tool force gages, traverse pressure recorder, and the differential analyzer.



"Gene" Smith boosts I.S.A. to Charleston group on Sept. 10.

Eugene H. Smith of the Charleston Section gave a forceful talk on the purposes of the Instrument Society of America for the benefit of the guests.

The meeting was preceded by a dinner for 95 people in honor of Mr. Lee. Approximately 200 persons attended the meeting.

—M. B. Lorig, *Secretary*

KANSAS CITY

At the first meeting of the Kansas City Industrial Instrumentation Society for the 1945-46 season, held September 25, R. H. Cooke of the Westinghouse Electric Corp. was appointed as our delegate to the national meeting of the I.S.A. R. L. Lewis of the Economy Equipment Co. will act as alternate delegate.

A nominating committee to present the names of nominees for officers for the coming year were elected as follows: R. J. Hunter, Standard Oil Co., Sugar Creek, Mo.; W. R. Carnes, Sinclair Refining Co.; H. B. Manley, J. F. Pritchard and Co.

Our guest speaker, Gordon Thomason of Mason Neilan Regulator Co., presented a splendid lecture on the development and application of the various types of control valves. The members were particularly interested in Thomason's explanation of the method for sizing a valve involving liquid and vaporization. Most of the members learned for the first time how a problem of this type could be solved.

We are continuing our drive to increase our membership. Anyone interested in instrumentation is cordially invited to attend our meetings and become a member of our local section of the National Instrument Society of America.

—W. A. Reichow, *President*

LOS ANGELES

The first regular fall meeting of the California Instrument Society was held at Eaton's Ardmore Cafe, 3550 Wilshire Boulevard, Tuesday evening, September 4, 1945.

Forty-eight attended the dinner, with about sixty present for the meeting.

Dr. Leslie W. Ball of Triplett & Barton, Inc., Burbank, Calif., gave a most interesting talk on "X-ray Equipment for Detection of Flaws in Various Metal Parts and Special Applications Developed during the War." Dr. Ball's talk was supported by numerous lantern slides. Some of the new and higher-voltage industrial x-ray equipments were shown and described, including some 2,000,000-volt equipment. Portable and field types were covered, including a complete field unit mounted on a specially-built, compact, small, two-wheeled trailer.

PHOTOGRAPHERS please note that only the "sharpest" glossies of "action shots" can stand reduction and processing.

A sound film was also shown through the courtesy of Taylor Instrument Companies of Rochester, N. Y., on the "Manufacture of Clinical Thermometers."

——M. D. Pugh, *Secretary*

NORTHERN INDIANA

The Northern Indiana section of the Instrument Society of America held its first meeting of the 1945-46 season on September 17 at the Ultra Modern Dining Room in East Chicago, Indiana.

The meeting was well attended. We were, however, disappointed in that our speaker for the evening, Mr. Arthur G. Mohaupt of De Forest's Training, Inc., Chicago, was ill and could not be with us. We were pleased to hear that Mr. Mohaupt, a well-known educator and engineer in the field of electronics, will be with us at a meeting later in the year, when we will hear his address on "Basic Principles of Industrial Electronics."

Following the dinner, a short business meeting was held in which our President, Kenneth Frame, outlined our position as members of the Instrument Society of America and gave us a résumé of progress being made on the job-placement project of our new organization. Secretary-Treasurer T. R. Stafford gave a report on the last Executive Committee meeting and read off the names of appointees to the various committees.

The evening was very ably rounded out by our new Program Committee Chairman, William Hitt, who gave an illustrated talk on the history and basic theory of the vacuum tube. Mr. Hitt called for, and received, comment and questions from the members. He finished his address by illustrating several interesting vacuum-tube applications.

—Edward White, *Publicity Chairman*

INSTRUMENT SOCIETY of AMERICA

President *pro tem:* Albert F. Sperry, 225 N. Michigan Ave., Chicago, Ill.

Vice President *pro tem:* Professor Carl Kayan, Columbia University, New York City.

Treasurer *pro tem:* Clarke E. Fry, 2331 Meadow Drive, Pittsburgh 21, Penna.

Secretary *pro tem:* Richard Rimbach, 1117 Wolfendale St., Pittsburgh 12, Penna.

For Committees see May issue of *Instruments*, pages 296-297.

PITTSBURGH

The first meeting of the Pittsburgh Section of The Instrument Society of America for the 1945-1946 season was held on September 24 at the Roosevelt Hotel.

At the business meeting the following reports were submitted: (1) report by Secretary; (2) report of Treasurer C. E. Fry; (3) report by P. G. Exline, Chairman of the Exhibit Committee; (4) report by Richard Rimbach, Secretary *pro tem* of the National Society; (5) report by A. H. Shafer, Delegate and Member of Constitution Committee. Mr. Shafer has been elected to represent the Pittsburgh Section at the Conference during October at the Carnegie Institute of Technology. (6) Report by R. E. Bailey, Chairman of the Board of Tellers. Mr. Bailey reported as follows: President, Paul G. Exline; Vice-President, S. W. Prince; Secretary, L. M. Susany; Treasurer, C. E. Fry. Councilors, R. J. S. Pigott, J. G. Kirkpatrick, A. B. Powell, C. L. Huffman, R. H. Knapper, and R. M. Kendig. (7) Report by S. W. Prince, Chairman, Membership Committee.

"Sam" Lee of G-E addresses Charleston group on Sept. 10.

Our guest speaker, D. M. Nielsen of The Foxboro Co., spoke on the "Electronic Measuring Instruments for Process Applications." Mr. Nielsen illustrated his lecture by means of slides and blackboard. A question and discussion period followed the lecture.

The dinner was attended by fifty-eight, with over one hundred members and guests present at the technical meeting.

—L. M. Susany, *Secretary*

ST. LOUIS

At the regular meeting held at the DeSoto Hotel on Sept. 25, 1945, the Saint Louis Society for Instrumentation voted unanimously to affiliate with the Instrument Society of America, and expects to send a delegate to the National meeting to be held October 19-21. Prior to the Sept. 25 meeting all members were sent a two-page circular prepared by the Executive Committee explaining the benefits of National affiliation, and much of the meeting was given over to further explanations by Chairman W. E. Boyle and Program Chairman [illegible] B. Freeman.

The technical part of the meeting consisted of two talks: First, an illustrated talk

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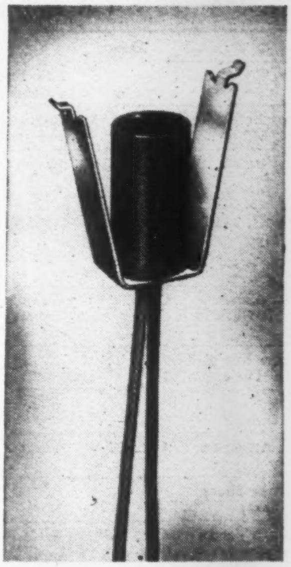

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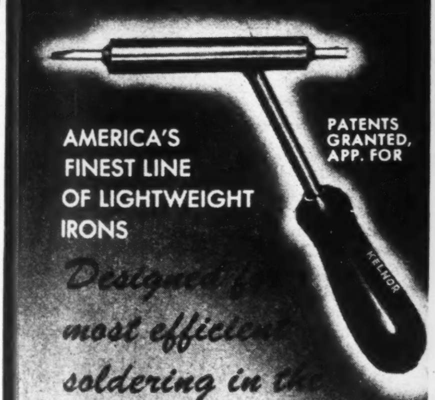
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INSTRUMENT SOCIETIES CALENDAR

City, Society and Secretary			Date	Place	Subject	Speaker
Atlanta, Georgia	Georgia Society for Measurement & Control	Robert E. Geminert, P.O. Box 1714, Atlanta		Blue Flame Room, Atlanta Gas Light Co.		
Baltimore Maryland	Baltimore Industrial Instrumentation Society	F. Ragan, Fuel Div., Beth Steel, Sparrows Pt., Md.	Oct. 27(B)	Engineers Club, 6 W. Fayette St., Balto.	Automatic Control	Donald E[illegible]n— Brown Inst[illegible]nt Co.
Charleston, W. Va.	Charleston Instrument Society	M. B. Lorig, 1506 Virginia St., Charleston 1	Nov. 12	Kanawha Hotel	Electronic Potentiometers	W. P. Wil[illegible]
Chicago, Illinois	Chicago Section, I. S. A.	A. J. Butler, c/o IHC, 2626 W. 31st Blvd., Chicago	Nov. 5(B) Dec. 3(B)	(To be announced) (To be announced)	Self-actuated Regulators Strain and torque meas. in aircraft	P. A. Elfers, [illegible]her Governor Co. L. S. Wasserm[illegible], AAC, Wright [illegible]eld
Cleveland, Ohio	Cleveland Instrumentation Society	A. J. McCullough, Minneapolis-Honeywell, 5005 Euclid Ave., Cleveland 3	Oct. 24(B)	Cleveland Engineering Society	Thermometers	Willis Hicks
Detroit, Mich.	Instrument Society of Detroit	Cliff Sackett, Chrysler Eng'g 12800 Oakland Ave. Det't				
Florence, Alabama	Muscle Shoals Instrument Society	J. W. Moffett, 323 E. Mobile St., Florence				
Fort Worth, Texas	Fort Worth Electronics Club	Ralph Ely, 1116 E. Arlington, Fort Worth	Oct. 18(A)	Texas Hotel, Fort Worth	Electrostatic Paint Detearing	H. F. Spreen, Texas Electric. Service Co.
Gulf Coast (Texas)	Gulf Coast Section, I. S. A.	C. D. Holt, 2509 Lake Shore Dr., Port Arthur, Texas				
Hartford, Conn.	Hartford Society for Measurement & Control	Gustave L. Manke, c/o Veeder-Root, Sargent & Garden Sts.	Oct. 16(B)	Bond Hotel	Electronics in Instrumentation	H. D. Middel, General Electric Co.
Kansas City, Missouri	KC Industrial Instrumentation Society	Gordon H. Burke, 1527 Broadway, Kansas City, Mo.	Oct. 30	Bluebird Cafeteria	Flow Measurement Eng'g	L. K. Spink, Foxboro
Los Angeles, Calif.	California Instrument Society	M. D. Pugh, 541 South Spring St., Los Angeles, Calif.		Melody Lane, Los Angeles		
Newark, N. J.	Society for Measurement & Control (New Jersey)	H. L. Close, 831 Dixie Lane, Plainfield, N. J.	Nov. 15(B)	Essex House	Instrumentation in Industrial Power Plant	Julius J. Berger, Cons. Engr. Newark
New York, N. Y.	New York Society for Measurement & Control	H. L. Hildenbrand, 206-07 33d Ave., Bayside, L.I., N.Y.	Oct. 29(B) Nov. 15(B)	Columbia U. Men's Faculty Club, 400 W. 117th St. Essex House, Newark, N. J.	(To be announced) (Joint meeting with N. J. Soc.—see above)	
N. Indiana	Northern Indiana Section, I. S. A.	C. P. Haynes, Red River Oil Refinery, 935 — 177th Place, Hammond, Ind.	Oct. 19(C)	Lake Hotel, 740 Washington St., Gary	Pneumatic Null Balance Applied to Ind'l Instr's	C. B. Moore, Pres., Moore Products
Philadelphia, Pa.	Philadelphia Society for Instrumentation	G. E. Gress, c/o ATC, 34 E. Logan St., Philadelphia	Oct 17(B)	Broadwood Hotel, Broad & Wood Sts.	Fractionating Column Control	L. H. Allen, Amer. Viscose Corp.
Pittsburgh, Pa.	Pittsburgh Section, I.S.A.	L. M. Susany, c/o Carnegie Institute, 4400 Forbes St.	Oct. 22(B) Nov. 26(B)	Roosevelt Hotel Roosevelt Hotel	Instrumentation in Plant Design Electronic Methods of Metals Testing	F. H. Trapnell, Du Pont Dr. E. R. Mann, Du Mont Labs.
St. Louis, Mo.	St. Louis Society for Instrumentation	Gus Holubeck, Union Electric Co., Venice, Ill.	Oct. 29(C)	DeSoto Hotel, 11th & Locust Sts.	Aircraft Instruments	Geo. Roepke, Aircraft Inst. Co.
Kingsport, Tenn.	Tennessee Section, I. S. A.	C. F. Palmer, 2924 J. C. Hwy., Kingsport	Oct. 10(C)	Kingsport Inn		Warren C. Gray, Taylor Inst. Cos.
Toronto, Ontario	Canadian Society for Measurement & Control	T. C. Agnew, Minneapolis-Honeywell Reg. Co.		Diana Sweets, 188 Bloor St. W., Toronto		
Washington, D. C.	Instrument Society of Washington	W. A. Wildhack, National Bureau of Standards, Wash'n	Oct. 16(D)	Interior Dep't Auditorium	Electronic Aircraft Controls	Gordon Rosholt Minn.-Honeywell
Whiting, Indiana	Whiting Instrument Men's Guild	Lloyd Clouse, 7344 Dante Ave., Chicago 19, Illinois				
Wyandotte, Mich.	Instrument Society of Wayne County	Wilson Fox, 33 Chestnut St., Wyandotte, Mich.	Oct. 22(B)	West Mound Methodist Church	Telemetering	Perry Borden, Bristol Co.

(A) Meeting at 7:30, no dinner (B) Dinner at 6:30, meeting at 8 (C) Dinner at 7, meeting at 8 (D) Meeting at 8, no dinn[illegible]

by H. J. Miller of the Pittsburgh Plate Glass Co., Crystal City, Mo., who explained the method of pressure control used on the large glass melting and rolling equipment at Crystal City. Troubles were discussed and reasons for the final arrangement of pressure taps were explained.

The second talk was by L. D. Cipriano of the Monsanto Chemical Co., E. St. Louis, Ill., who outlined the method of automatic control of specific gravity of hydrochloric acid used in one of the Monsanto installations. This entailed regulating the amount of water entering the hydrochloric gas absorber, in accordance with the variable amount of gas entering, to maintain the specific gravity of the resulting hydrochloric acid within commercial limits. The automatic control installation resulted in an increase of 12% in yield of acid, and better quality of acid.

—H. E. Zeffren, *Secretary*

WYANDOTTE, MICH.

The Instrument Society of Wayne County opened the 1945-46 season with a Symposium on Electronics. Mr. Barnum of the Brown Instrument Company was co-ordinator. He sent out a pep letter to all of our members, arranged the program and got the speakers. Mr. Kane of the Detroit Edison spoke on Fundamentals; Mr. Zimmerman of Chrysler Corporation spoke on the "magic eye" as used in titrating solutions; Mr. Sherba of Detrola on the Oscilloscope and relaxation oscillator and Mr. Linstrom of Westinghouse on the Mass Spectrometer.

Each speaker answered several questions from the audience. We are greatly indebted to Mr. Barnum for bringing us this fine program.

—John MacPherson, *Vice-President*

OTHER SOCIETIES

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS

The Society for Experimental Stress Analysis will hold its annual meeting at the Hotel Astor, New York City, on November 26, 27, and 28, 1945.—W. M. Murry, *Sec.-Treas.*, Box 168, Cambridge 39, Mass.

SOUTHERN CALIFORNIA METER ASSOCIATION

The October meeting of the Southern California Meter Association will be held at the Rio Hondo Country Club, Downey, Calif., on October 18th. Dinner will be at 6:30 and the meeting will start at 8:00 p.m.

A technical paper, "Characteristics of Differential Flow Meters and Factors Affecting Their Operation," written by L. K. Spink, Engineer in Charge of Flow Measurement, The Foxboro Company, will be presented by Frank J. Renner, Los Angeles Branch Manager of The Foxboro Company. This paper analyzes the reasons for possible errors in, and sets forth the limitations of the differential type meter.

To balance the meeting, a technicolor movie entitled "Mexican Joy Ride" will be shown. Produced by Miss Mildred Green[illegible] during an extended stay in Mexico, the picture is a narrative type film covering a trip from the United States to Mexico City, completed only six months ago.

At the September 20th meeting a very good turnout occurred, and Mr. Gavi[illegible] Younkin, Pacific Manager of Brown Instrument Company, spoke on the Theory, Operation and Servicing of Brown "Electronik" Instruments. A very interesting talk on football—Past, Present and Future, also was made by Deke Houlgate. Deke, recently Major Deke Houlgate of the Army Air Forces, is well-known in Southern California for the correctness of his predictions of football scores and ratings.

—Charles Meriam, *Publicity Chairman*

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TACHOMETERS

Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the no-stamp-needed card on the facing page.

M-264 **Stiffness Gage.** 6-page 8½" × 11" folder gives the description and uses of the "V-5 Stiffness Gauge," which determines both initial and normal stiffness of sheet and wire specimens, while the elastic property "Resilience" can be calculated from the loss in stiffness under sustained deflection. Definitions of initial stiffness, basic stiffness and resilience are given. Taber Instrument Corporation, North Tonawanda, New York.

M-265 **"Uses Unlimited."** 2-page 8½" × 11" issue (identified as Vol. 1, No. 2) of this house organ features an article on "Typical control problems handled by micro-switch" and also carries a short discussion "Energy from atoms may revolutionize industry". Three new Micro products are illustrated and described. Micro Switch Division, Freeport, Illinois.

M-266 **Weight at a Glance.** 22-page 8½" × 11" Bulletin No. 375 describes and illustrates the "Weightometer." This instrument uses the moving belt as the scale platform and combines the speed of the belt with the variable deflection caused by the load on the belt, to determine and to continuously totalize the weight. It may be used with a new conveyor or engineered to suit existing conveyor. A number of typical conveyor arrangements with Weightometer are shown to assist in determining applications, and instructions for planning the most satisfactory installation are given. Merrick Scale Mfg. Company, Passaic, New Jersey.

M-267 **Vibrators, Vibrator-operated and Rectifier Power Supplies.** 4-page 8½" × 11" Catalog No. 244 describes and illustrates new models for radio inverters (standard and heavy duty), industrial inverters (standard and heavy duty), vibrator packs (heavy duty), A battery eliminators, low power inverters and inverter vibrators. American Television and Radio Co., St. Paul, Minnesota.

M-268 **Determination of Liquid Level by Volume or Weight.** 8-page 8½" × 11" bulletin EX-101 describes construction, operation and application of a new series of instruments of laboratory standards designed for commercial use for hydrostatic measurement of liquids in storage, blending and mixing tanks containing oils, chemicals, paints, food products, etc. Capacities of the nine basic models range from 38" of water for model "TR-12 up to 41' 0" for model "TM-35." Scales graduated in gallons, pounds, inches of depth, barrels or other units are offered as standard. King Engineering Company, Ann Arbor, Michigan.

M-269 **"Calorate" Meter.** 10-page 8½" × 11" booklet describes the Calorate Meter which represents a direct method of measuring the flow rate in thermal units of two gases mixed in any proportions where the specific gravity and heat value of each gas is given. The instrument registers the heat value per unit volume or specific gravity of the mixture, the rate of flow of the mixture, the flow rate in thermal units and integrates the total flow in the thermal units. A schematic diagram shows the working of the recorder. Three charts give the curves showing specific gravity and differential pressures at constant volume for mixed blast furnace and coke oven gas, the B.t.u. compensation curves for coke oven and natural gas mixtures, and the specific gravity and differential pressure at constant volume for mixed coke oven gas and natural gas. Ring Balance Instrument Co., 740 N. Franklin St., Chicago 10, Illinois.

M-270 **High Fidelity PA Amplifiers.** 4-page 8½" × 11" pamphlet describes the first in a new series of high fidelity PA-amplifiers. This instrument had its inception in the increasing demand for faithful reproduction of voice and music over the audible frequency range. Typical PA-30 frequency response curves are shown, all special features are listed and complete specifications have been drawn up. Clark Radio Equipment Corporation, 4313 Lincoln Avenue, Chicago 18, Illinois.

M-271 **"Instrument News".** 4-page 8½" × 11" June issue (identified as Vol. 2, No. 2) of this house organ has three descriptive articles: (1) Frahm harmonic analyzer (2) Midget "Megger" insulation testers and (3) "Ducter" low-resistance ohmmeter. Attention is also called to the recently published 28-page booklet "Report at Mid-Century" in celebration of their fiftieth anniversary. James G. Biddle Company, 1211 Arch Street, Philadelphia 7, Pa.

M-272 **Process Control Terms.** 16-page 8½" × 11" Technical Paper No. 100 written by H. Ziebolz, Chief Engineer, for the purpose of further clarifying the excellent work done by the Terminology Committee of Industrial Instruments and Regulators Division of the A.S.M.E. This booklet defines with descriptive drawings forty-five items and terms in a language understood by suppliers and users alike. Askania Regulator Co., 1603 S. Michigan Avenue, Chicago, Ill.

M-273 **"The General Radio Experimenter".** 12-page 6" × 9" issue (identified as Vol. 20, No. 1) of this house organ designed for engineers, scientists, technicians, and others interested in communication frequency measurement and control problems, is devoted to one article, "Development Engineering at the General Radio Company". The subheadings are: Introduction; Wartime development engineering; and Post war development. General Radio Co., 275 Massachusetts Avenue, Cambridge 39, Massachusetts.

M-274 **"Arc-Melt" Soldering Unit.** 4-page 8½" × 11" pamphlet describes and illustrates this new development in soldering units. It is especially adapted for intricate electronic work as the tip gets down into spaces which cannot be reached with the ordinary soldering iron. The heat is concentrated at the tip only. The copper plating of the rod has sufficient conductivity to permit use of long carbon and still concentrate heat at the tip. Wyse Laboratories, Dayton 2, Ohio.

M-275 **Differential Pressure Type Dial Indicator with Alarm Contact.** 2-page 8½" × 11" Bulletin 11C1 pictures and describes "Model 98" Indicator of the differential pressure type with alarm contact for indicating and signaling rate of flow of fluids in all process industries; cooling water and lubricating oils to prime mover bearings; cooling water to condensers and electrical transformers; and water to filters and softeners. The "Model 98" also serves as a liquid level indicator on boilers and tanks under pressure. The instrument employs a calibrated bellows unit for ranges of 0-50 "up to 0-200" W. C. in the place of mercury to balance out differential pressures. Barton Instrument Company, [illegible] East 38th Street, Los Angeles 11, California.

M-276 **Thermocouple Harness.** 4-page 8½" × 11" Bulletin No. 401 describes and pictures all types of multi-cylinder head and cylinder base harness with the thermocouples and/or connectors woven integral with tow glazed cotton glazed braids, impregnated with flame, oil and moisture resistant lacquer. All thermocouples are gathered integral at the rear blower case into a main manifold. This manifold may be any length depending on specific installation requirements. The terminal end of manifold may be fitted with AN-5538 connectors to fit terminal box or with multi point connectors such as an An-3106 series. Revere Company Wallingford, Connecticut.

M-277 **"Apparatus Headliners".** 8-page 4" × 8½" issue (designated as No. E 1101) of this house organ features the "Model B Elconap" combination electric ovens and hot air sterilizers. A special feature of these ovens is the selector part of the indirect make-and-break, automatically controlled, thermo regulator. The selector scale is graduated in both C. and F. and may be set by turning the regulating knob until the indicator points to the desired degree on the scale. A set screw permits minute regulator adjustment for comparison with the thermometer reading. Once the selector is set, the oven needs no further attention. Boder Scientific Company, 907-909 Penn Avenue, Pittsburgh 22, Pa.

M-278 **Vacuum Thermocouples.** 6-page 7" × 8½" Bulletin V 22 describes and lists a new improved series of vacuum thermocouples for high frequency measurements of current and voltage. Listing includes an extremely sensitive 1.2 milliampere range. Useful data concerning proper instruments for use with Field vacuum thermocouples is given. Thermocouples are now only 1" long and ½" in diameter. The "Thoroweld" process used in welding the thermocouples is claimed to result in high impact-resistance. For the first time, at normal current, 25 millivolts output, instead of the usual 5 millivolts. This makes it possible to use sturdy, high-torque instruments with these thermocouples. Field Electrical Instrument Co., 109 East 184th Street, New York 53, New York.

M-279 **Visual Gages.** 24-page 8½" × 11" booklet illustrates and describes the Sheffield visual gage as an indicating comparator, with either English or metric scale, used for checking external and internal dimensions: width, thickness, height, depth, diameter, taper, out-of-round, concentricity, the angularity of surfaces or angularity between a bore and a surface, and run-out. It may also be used for checking the critical elements of screw threads. Six models are shown with magnifications ranging from 500 to 1 to 20,000 to 1. The wide range of amplification provides a means for checking master and production gages, for toolroom work, for checking purchased parts on arrival, for process control and final inspection; and laboratory and research work. The Sheffield Corporation, Dayton 1, Ohio.

M-280 **"The Laboratory.** 20-page 6" × 9" issue (designated as Vol. 15, No. 4) of this house organ features the following articles: (1) Science develops new chemicals for war against insects, (2) New boron carbide mortar is hardest ever produced, (3) New funnel suppor aids laboratory filtering. (4) The reagent shelf. (5) Caroxite—a new, efficient indicating CO_2 absorbent. (6) New type of plastic tubing has flexibility and strength. (7) Improved tissuemat for embedding histological specimens. (8) A new, rapid colorimetric method for phosphorus in steel. (9) New lighting principle employed in improved Kahn Viewer. (10) Apparatus in the literature. Fisher Scientific Company, 717 Forbes Street, Pittsburgh, Pa.

M-2[illegible] **Time Delay Relays and Switches.** 6-page 8½" × 11" folder illustrates and describes the "Mark-Time" series of relays. Type EX461-E, momentary impulse timed interval type—breaks one circuit and makes the other at beginning of operating impulse, restoring original circuit at expiration of time interval following cessation of operating impulse. "Type EX475", sustained impulse delayed time interval type—breaks one circuit and makes the other after a timed interval following the beginning of the operating impulse, restoring the original circuit at the expiration of a second timed interval irrespective of the duration of the operating impulse. "Type Ex500-B", heavy duty delayed response sustained impulse duration type—closes after timed interval following beginning of operating impulse, remains closed for duration of operating impulse, opens at cessation of operating impulse. "Series EX511" switches—for automatic time control of vacuum tube plate circuits and similar applications. M. H. Rhodes, Inc., Hartford, Connecticut.

M-272 **Industrial Buyer's Bulletin.** 16-page 6" × 9" catalog listing equipment ordinarily difficult to obtain from stock. Various types of equipment available for immediate delivery for improving production, inspection and research facilities are shown, including steel tool room units, fans, slide rules, micrometers, counting scales, time switches, inverters, grinding tools, tool chests and wire strippers. Precision Equipment Co., 32 N. State Street, Chicago 2, Illinois.

M-283 **pH Measurement.** 4-page 8½" × 11" pamphlet pictures and describes equipment for pH measurements, pH titrations, oxidation-reduction titrations and EMF measurements. It is claimed that the correct pH value may be obtained instantly regardless of the range or the kind of material. The results are equally accurate whether you are dealing with liquid, viscous, semi-solids, clear, turbid or colored matter. No operational skill is required to make the measurements or to run titrations, either experimentally or routinely. Gamma Instrument Co., Inc., 95 Madison Avenue, New York 16, N. Y.

M-284 **Terminal Blocks.** 4-page 8½" × 11" pamphlet describes and illustrates ten types of terminal blocks which provide convenient junction points in the control wiring of such equipment as: dispatching and traffic signal systems, telephone and telegraph switch boards, talking motion picture equipment, radio receiving and transmission, battery nal systems, elevator control, recording charging equipment, fire and patrol sigclock systems, junction boxes, current transformers, meter testing devices, annunciator systems, and power switchboards. Burke Electric Company, Erie, Pa.

M-285 **Dynamometer.** 20-page 8" × 10½" booklet describes and illustrates the transmission or traction type dynamometer in which the force passed through the instrument causes a deformation which is indirectly proportional to the load and which is measured by mechanical means. Types for every industry and all jobs. W. C. Dillon & Co., Inc., 5410 West Harrison Street, Chicago 44, Illinois.

M-286 **"Introduction to Electronics."** 20-page 8½" × 11" booklet prepared by Dr. Walther Richter for the educational

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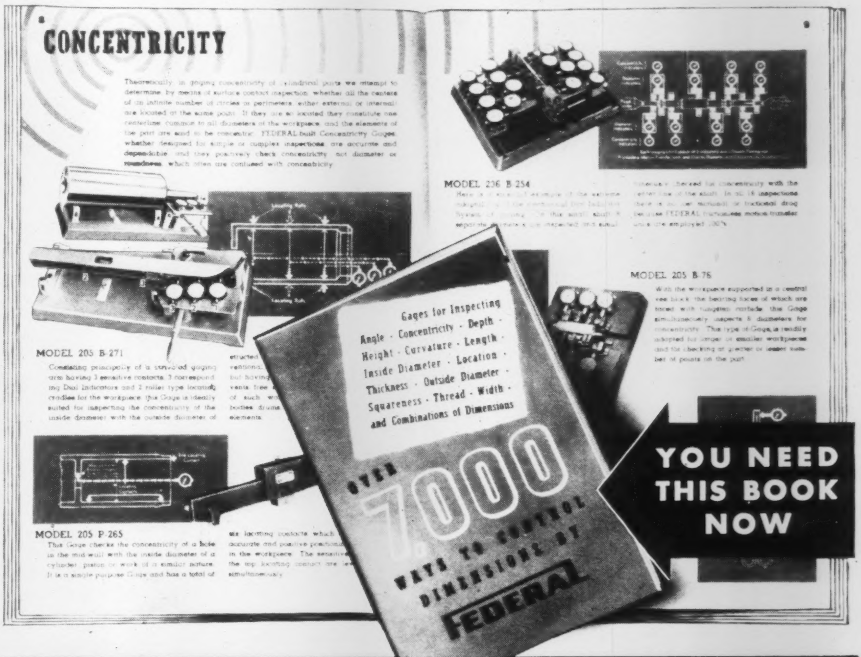
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